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THE NATIONAL PARKS COMMISSION

ALTHOUGH the National Parks Commission is still in the very early stages of its existence, there have been indications during the past few months that it is getting to work under more promising conditions than at one time seemed likely. The first three tasks commended to the Commission were the designation, at the rate of at least one or two every year, of areas of Britain as national parks, consideration of the provision of long-distance footpaths, and the preparation of a code for the guidance of townspeople in the countryside. Mr. Dalton announced in March that the first three national parks are to be established this year, in the Peak District, the Lake District and Snowdonia.

At the same time Mr. Dalton stated that the Pennine Way, to which Mr. Silkin, then Minister of Town and Country Planning, had directed the attention of the Commission in January, would probably be opened this year. Mr. Dalton referred to discussions in progress with the War Office, for alarm had been expressed in regard to the proposal to extend the Warcop artillery range in a way that would exclude the public from an essential part of this mountain footpath from the Peak to the Cheviots. On April 20, however, Mr. Dalton announced in the House of Commons that, on reconsideration of the matter at his request, and in the light of other circumstances, the Secretary of State for War had found it possible to exclude the Pennine Way from the proposed extension of the Warcop range. Mr. Dalton said that he had been assured that the beautiful and popular footpath would not be interfered with in any way by the long-term proposals of the War Office.

While Mr. Dalton acknowledged the sympathetic and co-operative spirit of the Secretary of State for War, and also the active and helpful participation in the discussion of Lord Lawson, the vice-chairman of the National Parks Commission, the manner in which this threat has been removed scarcely dispels misgivings as to future threats from the Services, or from other government departments, to the national park areas or to the long-distance footpaths. It does not appear that the Minister of Defence entered into the discussions at any stage, or that the War Office was called upon to justify its attitude either in relation to its other claims for land or to those of other Service departments. It would have been more reassuring for the future, too, if the evidence had pointed to the National Parks Commission having won the battle through its own authority and prestige rather than through the intervention of the Minister of Town and Country Planning or the benevolence of a particular Service minister.

Such a success in a particular instance accordingly in no way weakens the imperative necessity for some over-riding authority at Cabinet level, able to take a broad view from national and not departmental considerations when there is a clash of interests, and a Service department is unsympathetic or disposed

to contest the claims or authority of the National Parks Commission. To urge this is not to belittle Mr. Dalton's efforts, as Minister of Town and Country Planning, to establish co-operation and understanding with the Service ministries and with other departments such as agriculture and forestry, which have legitimate but conflicting interest in the use to which land is put in a small island like Great Britain. It is rather to repudiate Mr. Dalton's suggestion that objections to a particular area being taken for the exclusive use of the Forces are invalid unless alternative areas are suggested. In the first place, it is inherent in the idea of national parks that there are certain areas where the claims of amenity are paramount, and it is incumbent on the Services and other departments, therefore, to see that their requirements for land do not infringe those particular claims. In the second place, the limited area available in Great Britain means that there is a limit beyond which the demands of the Services, at least in time of peace, cannot be allowed to go without danger to the whole national economy and health. The onus must then lie on the Services of formulating other means of meeting their needs, and not on other bodies to suggest alternative areas.

Nevertheless, the more that can be done by co-operation and goodwill, the more effectively the various national needs are likely to be served. It should always be the exception for a dispute to require reference to an authority at Cabinet level, and the more clearly the purposes of the national parks are understood by government departments, landowners and the general public the less likely are difficulties to arise. So far as the general public is concerned, that is a main object of the code of conduct for the countryside which is to be produced under the Act by the National Parks Commission. It is, indeed, to be hoped that the code will be published and made familiar to school children and others before the national parks are established and the Act fully in force. Properly produced, such a booklet could profoundly affect for the better the relations between farmers and townspeople.

Much of the damage done in the countryside is, as Lord Carrington holds, the result of ignorance or carelessness, not of malice; and if the consequences of certain careless acts, such as leaving a gate open, were fully understood, co-operation should be easier to secure. Moreover, the considerable difference between the conception of a national park in Great Britain and in countries like the United States makes it all the more important that there should be no confusion or misunderstanding in the public mind.

The threat to the national parks does not by any means come solely from the Services. The Minister of Health has refused to sanction the North Cumberland Water Board's scheme with its threat to Ennerdale; but a new scheme is being submitted affecting Mosedale, one of the side valleys opening on to Lowes water. Although the Lake District is designated as one of the first three national parks, proposals vitally affecting it are thus being canvassed without prior reference to the Commission or to the Minister of Town and Country Planning. Fresh light has recently been shed on the British Electrical Authority's plans for new hydro-electric stations in North Wales, particularly in the Snowdonia area, designated as the third of the first three national parks.

The case against this plan is strongly argued in a pamphlet, "The Hydroelectric Schemes of the British Electrical Authority for the North Wales National Park", published by the North Wales (Hydroelectricity) Protection Committee, representing the Standing Committee on National Parks, the British Mountaineering Council and open-air organisations in Birmingham and Merseyside. Mr. A. R. Cooper, the divisional controller of the British Electrical Authority, has expounded and defended the plans to the members of the Welsh Board of Industry at Llandudno as well as in an article in the *Electrical Review* of January 27, since reprinted as a pamphlet. The financial aspects and the proposed lay-out were discussed by Mr. J. Warnock, the divisional hydro-electric engineer, in a subsequent article on February 17. Mr. Cooper makes the important points that the fuel requirements of steam stations in Great Britain are likely to be increased by some 10 million tons a year over the next five years, and that the distribution schemes which have been prepared by the Merseyside and North Wales Electricity Board will be less costly and are likely to be put in hand much earlier if they can be fed from comparatively low-voltage sources of power within the area. Mr. Warnock, however, faces the amenity issue squarely and deals with some of the objections raised to particular schemes, claiming that the developments as proposed should in no way impair the beauty of the Welsh landscapes. He admits, as Mr. Cooper's generalization does not, that as between the different schemes, some involve less effect on amenity than others, just as the schemes vary in cost; but he does not show that the schemes are interdependent or that there is good reason why the particular schemes should not be considered individually.

What is lacking, however, in both Mr. Warnock's and Mr. Cooper's review is an appreciation that despoiling of a national park area is to be opposed on principle. Some of the schemes, indeed, lie wholly or mainly outside the areas which the Hobhouse Committee recommended for the North Wales national park. To them the principle accordingly does not apply. But it is of the essence of the whole conception of a national park that, in certain limited areas where unspoilt natural beauty is properly regarded as a national resource, such countryside must be safeguarded against any other claims, and this interest of amenity must be paramount. The National Parks Act has been passed expressly to facilitate the preservation of natural beauty in such areas. If a statutory body or a government department is allowed to over-ride or nullify the Act, the whole meaning of the Act is stultified. In the nature of such a situation, there can be no compromise. Here amenity must come first, just as in other areas the claims of water supply, agriculture, military training, housing or industry must come first if conflict arises.

While it may well be that the economic advantages claimed for the North Wales hydro-electricity schemes are not so great as imagined, this is not the point on which the Protection Committee in its campaign deserves the support of all who take seriously the preservation of the finest mountain scenery of Wales. It is rather the point on which Dr. Julian Huxley insists: that failure in a national park area to make the preservation of natural beauty the supreme national interest is not only to repudiate the very conception and meaning of a national park but also to threaten the whole principle underlying the planned utilization of our limited resources. We must to the best of our judgment designate the social functions which in particular areas are to be paramount, and then see that those functions are, in fact, supreme.

More, therefore, than the future of the Snowdonia National Park is at stake in the present controversy over the Welsh power schemes, and an even keener interest will accordingly be taken in the nature of the planning body which Sir Patrick Duff indicated on May 4 was expected to be set up by the National Parks Commission for the Peak District National Park before the end of the year. Sir Patrick, who, with members of the Commission, afterwards spent three days surveying the Peak district with the view of defining the boundaries of the Park, would not commit himself at the present stage on the form that body would take. He emphasized, however, that the National Parks Act laid down clearly that the planning authority should be a joint board unless the county authorities could show good cause against it. That may well be a significant reference, and it should be noted and welcomed by all who have at heart the real meaning and purpose of the national parks, and are concerned that neither the nature of the planning authorities established nor controversy between alternative plans or schemes like those of the British Electrical Authority and the North Wales (Hydro-electricity) Protection Committee should obscure the real issues or impede the achievement of the full purpose of the National Parks Act. Meanwhile, evidence is already available that the National Parks Commission is addressing itself to its tasks with imagination as well as energy, and that it merits strong government support and clear public understanding.

PREHISTORY OF AERONAUTICS

Voyages to the Moon

By Marjorie Hope Nicolson. Pp. xvii+297+8 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1948.) 20*s*. net.

THIS book is not an easy one to classify, and the title is somewhat misleading, as it does not do justice to the more serious work contained. The author defines her scope as "tracing the idea of flight through the literature of the two centuries immediately preceding man's conquest of the air" (namely, the two hundred years before the first balloon ascents in 1783) and, more particularly, as treating with "the cosmic voyage as English readers knew it in the 17th and 18th centuries". The book is based on a series of lectures delivered in 1946 and is illustrated by engravings contemporary with the period under review.

Miss M. H. Nicolson (who enjoys a distinguished academic career in America) may thus appear to have joined the ranks of the historians of aeronautics; but the book is actually a study of literature, and the impact of science upon it, rather than an independent investigation of the development of the idea of human flight. This distinction, though perhaps a fine one, is important, for it constitutes the difference between the scientific and the non-scientific methods of approach to this subject. For example, it impels the author to cite (in her "subterranean" group) Lewis Carroll's "Alice in Wonderland" as "the greatest of English cosmic voyages", whereas it has little relevance, if any, to the problem of human flight. She might as easily have included "Through the Looking Glass" in her "voyages, planetary"; but she makes only bare mention in passing.

The fundamental basis of the idea of man's flight was, of course, the natural phenomenon; it was the inspiration and the only model, so that it is doubtful whether man would ever have conceived flight had Nature not provided the pattern. Hence, a scientific study of the development of the idea should include an appreciation of the natural sources and their relationship. This is not to say that Miss Nicolson's literary method has no value in aeronautical studies; on the contrary, it serves to illuminate the long period of aspiration which preceded that of the imitation of Nature and scientific enunciation of principles. In her interpretation of the classical literature of flight, she has drawn on and received inspiration from J. E. Hodgson and the late Berthold Laufer, whose writings—as she gracefully emphasizes in her bibliography—are unquestionably the most comprehensive and valuable in the English language. But she has not, apparently, consulted the contemporary works of Charles Dollfus in France.

The author's history of that which she terms "cosmic speculation" embraces the writings of such as Lucian, Cicero, Plutarch, Rabelais, Cervantes, Milton, Donne, Swedenborg, Rousseau, Thomas Gray, Samuel Johnson and the Jesuit natural philosopher, Kircher. These form the classical background to her thesis, which is, broadly speaking, that the history of the idea of flight does not date from, say, the scientific speculations of Leonardo da Vinci but from ancient literary traditions touched by the "new philosophy" of the sixteenth and seventeenth centuries—a contention which will be generally accepted. Miss Nicolson has many other sources for her investigation and has included some moderns actually outside her period, such as Poe, Jules Verne, H. G. Wells and (as already remarked) Lewis Carroll, who are examined as exponents of the imaginary voyage.

An immense amount of literary research has gone into the making of this book, and it bears the mark of scholarship. The annotated bibliographies of primary and secondary materials in various languages (some thirty pages) alone make it worth a place among aeronautical works of reference. With the excellent index, it is possible for the reader to review conveniently the classical allusions to flight, which after all—and irrespective of the fact that they are flights of fancy—are the strongest evidence of man's primeval and enduring desire to emulate Nature in that accomplishment naturally denied to him.

M. J. B. DAVY

FIFTY YEARS OF PROGRESS IN SOIL MICROBIOLOGY

Microbiologie du sol

Problèmes et méthodes ; cinquante ans de recherches. Par Prof. S. Winogradsky. Pp. 826+35 plates. (Paris : Masson et Cie., 1949.) 3,000 francs.

PROF. S. WINOGRADSKY presents the results of fifty years work in this volume ; it consists of all his principal papers gathered together and reprinted in ten sections. There are also forewords to each section summarizing the position in 1945, a brief introduction to the whole volume, and a final section on the principles of ecological microbiology ; but, with these exceptions, all the work has been published elsewhere.

In the introduction it is stated that the memoirs, especially the earlier ones, have been pruned of unnecessary details and that certain passages have been condensed. This is a pity. Such changes detract from the historical interest of the volume, and sometimes introduce a modern note, out of keeping with the leisurely tempo of the scientific papers of the past century.

There are very few bacteriologists whose work has covered such wide fields as that of Prof. Winogradsky, and not many who have willingly adopted so many new points of view. The author saw the birth of modern microbiology and has watched its development through infancy and childhood to adolescence ; and at every stage he has helped it on by noteworthy contributions. His early work on nitrification attracted the attention of Pasteur himself and resulted in an invitation to work at the Institut Pasteur ; but for various reasons this invitation was not accepted until its renewal by Dr. Roux in 1922. Within the sections the papers are arranged chronologically, and to some extent the order of the sections themselves reflects their author's changing interests. The subjects fall into the following subdivisions : the first autotrophs, bacterial morphology, nitrification, anaerobic nitrogen fixation, retting of flax, special methods in soil microbiology, cellulose decomposition, aerobic nitrogen fixation, symbiotic fixation and ecological principles.

Prof. Winogradsky's scientific career began with the recognition of a new type of nutrition, when he described the autotrophic sulphur bacteria in 1887. His first paper on nitrification was published in 1890, when the work of Schloesing and Muntz had established the fact that nitrification in soil was brought about by micro-organisms. Various workers, notably Warington, Heræus, Frank, Adametz and the Franklands, had already been trying to isolate a nitrifying organism in pure culture ; and Warington must have been very near it, and the Franklands undoubtedly had succeeded. At this point Winogradsky, in his own words, decided "à laisser de côté . . . toutes les formules, et à procéder lentement mais sûrement". In this revised version the sentence is rendered "à procéder en me tenant à une méthode la plus strictement inductive". The classical work on *Nitrosomonas* and *Nitrobacter* which resulted from this decision is too well known to need further comment.

There are very few papers representing the years between 1895–23. In the decade following his appointment to the Pasteur Institute, Prof. Winogradsky was largely preoccupied with methods for studying the microflora of soils. This was his peak period of production, when he was not only devising and describing new methods, but also applying them to the elucidation of old problems ; at this time most of his work on *Azotobacter* and symbiotic nitrogen fixation and on the decomposition of cellulose was done. He also returned to his earlier loves, the autotrophic bacteria.

The book provides a running commentary on the science of non-medical bacteriology during the past sixty years ; and at the present time the author is still as ready to plead for a new outlook, and new methods of attack, as he was in the last years of the past century. All soil microbiologists will be grateful to have these papers collected into a single volume where they are readily accessible.

MODE OF ACTION OF SELECTIVE ANTIBIOTICS

Selective Toxicity and Antibiotics

(Symposia of the Society for Experimental Biology, No. 3 : Published for the Company of Biologists on behalf of the Society for Experimental Biology.) Pp. vii+372. (Cambridge : At the University Press, 1949.) 35*s*. net.

THIS volume contains twenty-two papers read at Edinburgh in July 1948 and is the third of an annual series of symposium reports. The papers cover a wide range, and it is perhaps unfortunate that the editors have not thought it necessary to arrange them in a logical order with related subjects grouped together, and that no paper is furnished with a summary.

W. A. Sexton writes a most fitting preface entitled "The Organic Chemist's Approach to Chemotherapy", indicating how neatly the chemical pattern of a homologous series sometimes fits with the biological features of toxicity, retardation of growth, inhibition of germination or lethal action upon bacteria, fungi and protozoa. He remarks also upon a theme which runs throughout most of the other papers in this series, that many of the chemical constituents of living matter are in a constant state of change in that their synthesis and breakdown occur continually throughout life. From this single basic fact emerges the important guiding principle which governs the selective toxicity and antibiotic action of different chemicals, namely, their action upon enzymes and enzymatic systems, whereby they exert an indirect effect upon vital processes rather than a direct lethal action upon the corpus as a whole.

This view is reflected in papers on "The Study of Enzymes in relation to Selective Toxicity in Animal Tissues" (R. A. Peters) ; "The Design of Bacterial Inhibitors modelled on Essential Metabolites" (H. N. Rydon) ; "Aspects of Selective Toxicity of Sulphonamides and other Anti-Metabolite Inhibitors" (D. D. Woods and R. H. Nimmo-Smith) ; and "The Action of Penicillin on the Assimilation and Utilization of Amino-acids by Gram-Positive Bacteria" (E. F. Gale).

A number of papers are devoted to *ad hoc* problems such as the antibiotics derived from *Bacillus polymyxa* (G. Brownlee) and the resins of hops (L. R. Bishop) ; the effects of surface activity and permeability (A. R. Trim and A. E. Alexander) and of various fatty acids on the growth of different bacteria (M. R. Pollock ; E. Kodicek) ; of phenylcarbamates on higher plants (G. W. Ivens and G. E. Blackman) ; the significance

of hydrogen-ion concentration (E. W. Simon and G. E. Blackman) and the influence of diet upon toxicity (L. A. Elson). A further series can be grouped as dealing with selective drug action on protozoal blood infections (F. L. Rose; E. M. Lourie), drug resistance (C. N. Hinshelwood) and ecological adaptation (C. E. Lucas).

The volume, indeed, contains a mine of information relating to the growing points of the fascinating subject of chemotherapy and should appeal to all who have an interest in this science.

LIONEL WHITBY

AMERICAN BIRDS OF PREY

Catalogue of Birds of the Americas and the Adjacent Islands

By Charles E. Hellmayr and Boardman Conover. Part 1, No. 4: Cathartidæ—Accipitridæ—Pandionidæ—Falconidæ. (Zoological Series, Vol. 13, Publication 634.) Pp. vi+358. (Chicago: Field Museum of Natural History, 1949.) 4 dollars.

THIS number of the "Catalogue of Birds of the Americas" completes the work which was commenced in 1918 by C. B. Cory. Unfortunately Cory died in 1921 before he had finished the third number; but, thanks to the generosity of a life-long friend, the Field Museum was enabled to secure the services of Dr. C. E. Hellmayr to continue the work. No better choice could have been made, since Hellmayr had already made a special study of neotropical birds and was familiar with the collections in the principal museums of Europe. This last point is important when it is realized that up to the middle of the nineteenth century, or possibly later, most of the work on South American birds was based upon collections in Europe.

After Hellmayr came to Europe, it was considered desirable that there should be someone in Chicago to assist in the preparation of this "Catalogue". Accordingly, Mr. Boardman Conover, a research associate of the Field Museum, who was specially interested in ducks and game birds, was appointed to collaborate with Hellmayr. During the autumn of 1938 Hellmayr was working in London in the British Museum (Natural History), and in the summer of 1939 he went with his wife for a holiday to the south of France, but before leaving London sent a duplicate copy of his manuscript to America. On the outbreak of war he decided to go to Switzerland instead of returning to England, and there he remained until his death in 1944. After the War the original manuscripts were sent to America, and it was found necessary to bring them up to date. Not only were there many bibliographical references to be added, but also during the six years of war there had been numerous accessions to the Museum collection. For all this later work Mr. Conover is responsible.

This concluding section of the "Catalogue" deals with the birds of prey, and, as in previous numbers, the descriptions are reproduced of all the new forms described since the British Museum "Catalogue of Birds" was published and which the authors recognize. In addition, many doubtful points on nomenclature and distribution are fully discussed. Attention has already been directed to Hellmayr's knowledge of the collections in European museums, and time and again there are notes on supposed types or old types which he discovered. For example, he devotes half a page to convincing doubtful critics that the specimen in the British Museum of *Butio harlani* is the one described by Audubon and therefore the type. This "Catalogue" will be invaluable to all students of American birds and to those interested in their geographical distribution. Mr. Conover is to be congratulated on his work in completing this valuable "Catalogue".

TEACHING OF INVERTEBRATE ANATOMY

Practical Invertebrate Anatomy

By Dr. W. S. Bullough. Pp. xi+463. (London: Macmillan and Co., Ltd., 1950.) 28*s*. net.

DR. BULLOUGH has used the drawings which he prepared for the elementary series, already published on cards, as the basis of a book on practical zoology, with text and figures, suitable for those studying for a general degree. By choosing 122 commonly studied examples of invertebrate animals, he hopes that the book will be used both by North American and British students, and that those in other parts of the world will find related genera to which his figures can be adapted.

His plan is to classify the type genus, to tell where it occurs, how it lives and feeds, how to prepare it for study, and how to dissect or mount it in order to investigate its structure. To assist the student in interpreting what he finds, there are 168 very clear line-block illustrations, some based on those in the monographs listed at the end of the sections, but most original. These are excellent, with few errors, and are fully labelled. Those who have had experience of reducing complex animal structure to semi-diagrammatic form will appreciate the immense knowledge and labour involved in preparing these figures. The slightest exaggeration of a line in the final draft may alter the effect, as has, in fact, occurred in Fig. 114, where thickening of the line has resulted in making the shell plates of this *Chiton* appear to overlap from foot to head, instead of, as stated in the text, from head to foot. But this and other minor faults do not detract seriously from a most valuable collection of drawings.

The choice of types is wide, and though some might like to see included an Acinetarian, a nemertine, *Phoronis*, *Carcinus* and a nudibranch, it is comprehensive enough to provide a much-needed and useful contribution to practical classes.

Each phylum has an appendix dealing with the treatment of the material, starting with the living animal, and proceeding with culture methods, killing, fixing and preserving. These directions will be of interest not only to the student but also to his teacher, especially as the information is concise and not too technical. A general appendix of fixatives, preservatives and stains is also useful. But why suggest "adding crystals of magnesium sulphate to the small volume of water in which they are confined" for the narcotization of marine animals? That method has been superseded by the much more effective isotonic solution of magnesium chloride.

There are a few mistakes in technical terms; but these can be easily spotted and corrected. The book can be highly recommended, and both author and publisher are to be congratulated on an excellent production.

Publications of the Hudson's Bay Record Society, Vol. 11

Edited by E. E. Rich, assisted by A. M. Johnson. (Copy-Book of Letters Outward &c., Begins 29th May 1680, Ends 5 July 1687.) Edited by E. E. Rich, assisted by A. M. Johnson. Pp. xli+416+x. (London: Hudson's Bay Record Society, 1948.) n.p.

THIS large, beautifully produced book appears at first sight forbidding and dull; but it is far from being either. It consists mainly of letters sent from the Hudson's Bay Company to its servants on the shores of the Bay. These letters deal with the everyday life of the servants, the prevention of trespass by interlopers, the founding of new settlements, and the quarrels with the French as to rights of the Company in North America. In all these matters there is much that is still of interest. There is a homely touch, in a letter to Governor Nixon: "We have sent you a qr. cask of choice Malaga Sack for your owne drinking, we have likewise sent a Cask of Noremberg Toyes for childrens play games to make an experiment how such things will take with the Indians". There is reproof: Mr. Mussenden is told "we hope we shall heare no more of such factions and disorders", and Governor Nixon that "you have carried your selfe with too much inhumanity and cruelty towards the Natives". A long section of the correspondence deals with the French menace, and the documents setting out the English title to Hudson Bay are of great interest.

Such details as these must be picked out by careful reading. But the whole of the correspondence is welded together in a brilliant introduction by Prof. E. G. R. Taylor. She reviews the state of cartographical knowledge in the period and shows how this was related to claims of the disputants. She shows how ignorance of the geography of the new lands both affected the actual settlements and mystified the directors of the Company in London. Sometimes she reads into the seventeenth century facts which are more relevant of our own times, as, for example, the different way in which Russians and East Europeans would have tackled the problems set to Englishmen. But this does not detract from a most enlightening introduction to this valuable work. J. N. L. B.

Twilight in India

By Gervee Baronte. Pp. xix+382. (New York: Philosophical Library, Inc., 1949.) 3·75 dollars.

THIS book is well named, for the author has a very dim view of India. In spite of a good deal of interesting and, on the whole, well-informed matter on south Indian castes, the whole book is coloured by an obvious determination to view everything Hindu in the darkest shadow, and all the less creditable aspects of Hinduism, particularly in regard to sex, are enlarged on at the expense of its merits.

There is obviously a good deal of exaggeration in many of the statements made, for the *meriah* sacrifice is written of—and that in 1949—as if it continued as a routine ceremonial. Several of the illustrations are borrowed without acknowledgment from Thurston; and, although misprints abound, the fact that "tumeric" is repeatedly used for "turmeric" suggests that possibly it is not the printer who is to blame for "foistered" instead of "foisted"—or perhaps "fostered".

The most valuable part of this volume is constituted by the twelve chapters (there are twenty-six in all) on castes; but one can only use them with a certain dubious reserve engendered by doubts arising not only from the author's obviously biased approach, but also from suspicions that she has been wishfully credulous of the monstrous and the unpleasant, and from the perusal of statements which are manifestly not in accordance with the facts: "Most of the I.C.S.," she tells us, "knew only the North, which, . . . is not India. . . . It is only in the Dravidian south that one meets real Hinduism." Both statements are misleading. J. H. HUTTON

Das Molekül und der Aufbau der Materie

Vorträge von W. Kossel, F. Hund, E. Justi, O. Kratky und P. A. Thiessen. Herausgegeben von K. W. Wagner. (Die Wissenschaft, Band 101.) Pp. vii+319. (Braunschweig: Friedr. Vieweg und Sohn, 1949.) 18.80 D. marks.

THIS volume contains the text of lectures given in 1943–44, and hence in many aspects it cannot claim to give the present-day state of the subjects dealt with. These are heteropolar compounds and the growth of crystals by W. Kossel (occupying the first 119 pages), homopolar compounds and the quantum theory of valency by F. Hund, the calculation of specific heats of gases from spectrum data by E. Justi, macromolecules by O. Kratky (which has been revised), and colloids by P. A. Thiessen.

The last two are very short and elementary. The longer articles give a very good picture of the subjects at the time the lectures were given, and the book contains much of permanent value, the articles by Kossel and Hund being particularly noteworthy. The section by Justi does not include any recent work except his own publications and gives, in consequence, a rather misleading picture of the present position in this field.

Since most of the recent work on all the topics dealt with has been done outside Germany, it is doubtful whether this volume, interesting as it is, will add very much to the existing literature in its field.

Normal Values in Clinical Medicine

By Prof. F. William Sunderman and Dr. Frederick Boerner. Pp. xxx+835. (Philadelphia and London: W. B. Saunders Co., 1949.) 14 dollars; 70*s*.

PROF. SUNDERMAN and the late Dr. Boerner, in conjunction with several colleagues, mainly of the University of Pennsylvania, are to be congratulated on having brought together in the compass of one book so much valuable information concerning normal values in clinical medicine. This must make it a very useful reference book and one which should ease the burden of the busy clinician, while the number of collaborators each covering his own particular field must add to the reliability of the information.

Without a knowledge of 'normals', abnormals are not easily determined, the more so in clinical medicine where the range of normal may be wide. It is probable there are certain omissions—they are difficult to find—since should the reader wish to know the average number of 'chews' per test-meal, he will find a paragraph devoted to the subject. There is an up-to-date bibliography at the end of each chapter.

The last section, on "Miscellaneous Data", although not pertinent to normal values in clinical medicine, is usefully incorporated. The book should not only satisfy the requirements of the clinician but should also be of value to the student of advanced physiology as well as "the enquiring medical student".

THE LIQUID-SOLID TRANSITION IN HELIUM NEAR ABSOLUTE ZERO

By Prof. F. E. SIMON, C.B.E., F.R.S., and C. A. SWENSON*
Clarendon Laboratory, Oxford

THE properties of helium are profoundly affected by the zero point energy[1,2] as a consequence of a combination of low atomic weight and weak interatomic forces. At a specific volume which one would expect for normal solids, the zero point energy would be of such magnitude as to make a crystalline state under its own vapour pressure unstable. The system escapes into a state of bigger volume—just held together by the attractive forces—with consequently smaller zero point energy; the atoms are now kept floating well apart at such distances that the normal repulsive forces play no determining part. The fields of force do not interlock, and helium is a liquid of very low viscosity even above the λ-point. At absolute zero the total 'lattice' energy per mol. is about 60 cal., of which about 45 cal. are compensated by zero point energy, so that the observed heat of evaporation is reduced to 15 cal. As the thermal energy of liquid helium is only 0·01 cal./mol. at 1°, it is completely negligible in comparison with the zero point energy, and there is therefore no reason why solidification should occur at lower temperatures. Indeed, it has been observed that helium is still liquid at 0·05° [3].

It has been shown by Keesom[4] that helium can be solidified under pressure. The reduction in volume by pressure brings the atoms sufficiently near to each other for the fields of force to interlock, and the system goes over discontinuously into the crystalline state. Although solid helium cannot be regarded in all respects as an ordinary solid—again because of its high zero point energy—it nevertheless does exhibit properties characteristic of one: X-ray diagrams have proved a normal structure (close-packed hexagonal); also it is so hard that it can block capillaries against considerable pressures. Of course, solid helium is in a highly degenerate state: its specific heat, although it does not follow exactly a Debye curve, corresponds to characteristic temperatures of 25–35°.

The study of the melting curve of helium is of interest for two reasons. As has been shown elsewhere[5], helium can be used to carry out model experiments at very 'high' temperatures, and in some recent experiments we were able to solidify helium at about ten times its critical temperature[6]. The other point of interest concerns the low-temperature region, with which the following discussions deal.

According to the Third Law of Thermodynamics, entropy differences must disappear at absolute zero. Therefore, as the entropy of the crystal approaches zero at absolute zero, so must that of the liquid, although a liquid is not usually regarded as an example of an ordered phase. The loss of entropy takes place in a relatively narrow temperature interval below the λ-point, and at 1° only a negligible amount of entropy is left in the liquid. This 'liquid degeneracy' gives rise to the now very familiar queer properties of liquid helium.

It also has a very important consequence for the melting curve. The Clausius–Clapeyron equation expresses the temperature coefficient of the melting pressure (P) as the quotient of entropy change over volume change. This means that dP/dT has to approach zero with falling temperature. This was confirmed qualitatively by Keesom's first experiments. (Fig. 1 shows the equilibrium diagram and includes the latest values.) Keesom[7] himself, however, is not yet satisfied that his experiments prove it beyond doubt. We have now repeated more accurately and extended to lower temperatures the measurements of the melting pressure.

A second type of experiment concerns the energy relations between the two phases. The disappearance of the entropy difference means *a fortiori* the disappearance of the heat of melting $\rho = T\Delta S$. Now as $\rho = \Delta U + P\Delta V$, it can become zero in two ways: one way is that both energy difference (ΔU) and volume difference (ΔV) disappear; in other words, the two phases become identical. There are no indications whatsoever for this course. The other alternative is that ΔU approaches the value $(-P\Delta V)$ with falling temperature. This was predicted some time ago[1] from the then existing data. It means that the energy of the liquid would be lower than that of the solid, in contradiction to all cases known so far. If a volume difference persists down to absolute zero, together with a positive melting pressure (ordinary substances would have a negative melting pressure at absolute zero[8]), this behaviour necessarily follows: there is no development of heat at absolute zero and, therefore, in compressing the liquid to the solid, the free energy put into the system must result in increasing the energy of the solid above that of the liquid. Although this consequence is unavoidable, it seemed so strange that Keesom[3] has not accepted it. (Prof. A. Michels has pointed out to us another simple way of showing

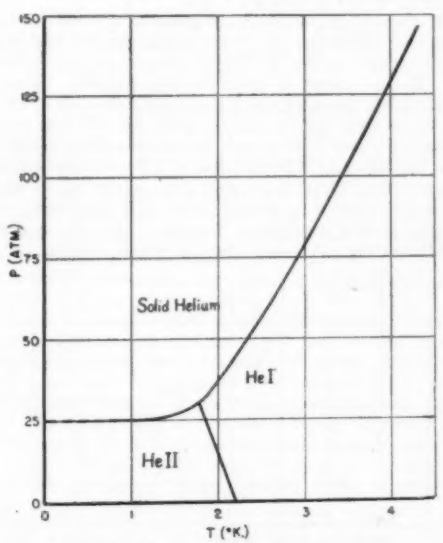


Fig. 1. Equilibrium diagram solid–liquid helium

* Now at Harvard University.

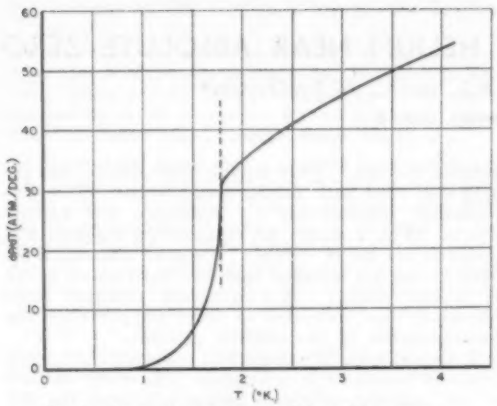


Fig. 2. Temperature coefficient of the melting pressure

that the energy difference must change sign. It follows from the Clausius–Clapeyron equation that:

$$\frac{\Delta U}{T\,\Delta V} = \frac{dP}{dT} - \frac{P}{T}.$$

If, therefore, a tangent can be drawn from the point ($P = 0$, $T = 0$) to the melting pressure curve—as is the case for helium—the energy difference must change sign at the temperature of the point of contact.)

The *P*—*T* Dependence

The experimental details will be described soon in a paper in the *Physical Review*, and we shall discuss here only the main consequences of our results. The melting pressures have been measured with a relative accuracy of 0·01 atm. at sixty points between 1·0° and 1·85°, the majority by the method of the blocked capillary. While the values at the higher temperatures agree well with those of Keesom, there is a distinct discrepancy at the low-temperature end. The melting pressure between 1·0° and 1·4° can be represented by $P = 25{\cdot}00 + 0{\cdot}053\,T^3$ atm.

In Fig. 2 we give the values of dP/dT derived from our results at the lower temperatures and from the Leyden[9] values at higher temperatures. Above, say, 2° the curve is more or less normal. Then a break takes place at the λ-point (which is at 1·77° at the corresponding pressure) and dP/dT disappears quickly; below 1·4° it can be expressed by $0{\cdot}425\,T^7$. The fact that dP/dT vanishes as T^7 is a very striking proof of the Third Law, and it is one of those which should replace the rather stale and inaccurate example of the transition between the two sulphur modifications, the mainstay of most text-books.

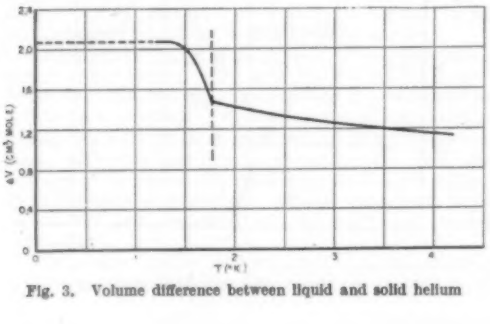


Fig. 3. Volume difference between liquid and solid helium

The Energy Relations

In order to determine the energy relations, we have measured the volume change during melting by means of a very simple pressure-balance method; twenty-five points were taken between 1·2° and 2° with an accuracy of about 3 per cent. In Fig. 3, ΔV is plotted as a function of T, combined with the Leyden values[9] at the higher temperatures. We see that the volume difference increases with falling temperature, again with a break at the λ-point; below 1·4° the values are independent of temperature. As mentioned before, practically no thermal energy is left in either of the phases at 1°, and as in addition the pressure is constant, there is no reason why the volume difference should show any change below 1°.

The heat of melting can be calculated from dP/dT and ΔV, and we find below 1·4°: $\rho = 0{\cdot}021\ 7^8$ cal./mol.

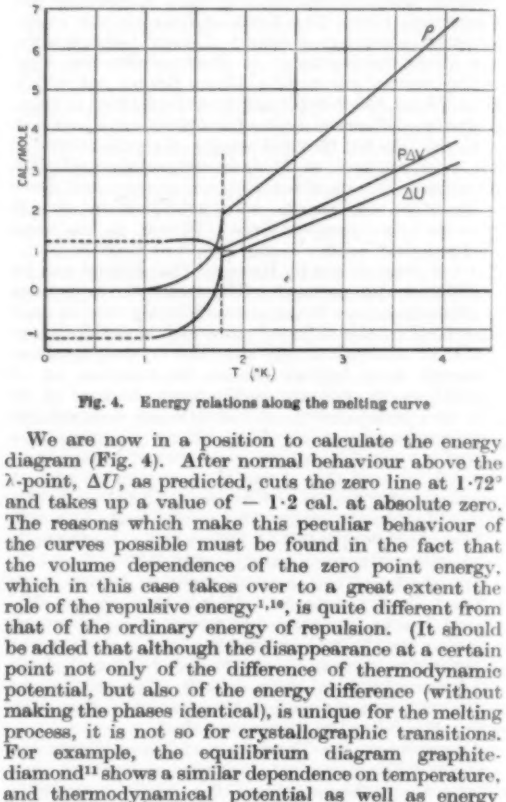


Fig. 4. Energy relations along the melting curve

We are now in a position to calculate the energy diagram (Fig. 4). After normal behaviour above the λ-point, ΔU, as predicted, cuts the zero line at 1·72° and takes up a value of − 1·2 cal. at absolute zero. The reasons which make this peculiar behaviour of the curves possible must be found in the fact that the volume dependence of the zero point energy, which in this case takes over to a great extent the role of the repulsive energy[1,10], is quite different from that of the ordinary energy of repulsion. (It should be added that although the disappearance at a certain point not only of the difference of thermodynamic potential, but also of the energy difference (without making the phases identical), is unique for the melting process, it is not so for crystallographic transitions. For example, the equilibrium diagram graphite-diamond[11] shows a similar dependence on temperature, and thermodynamical potential as well as energy of the two phases should become equal at about 1,100° K.)

Making use of the data of volumes and compressibility determined at Leyden[9], we now give in the accompanying table values of volume and density (d) of liquid helium at zero pressure, of liquid helium in equilibrium with the solid, and of solid helium in equilibrium with the liquid. We also give in column 5 the corresponding values for the energy, putting the energy of the gas at absolute zero equal to zero[12].

We have added (in italics) in a sixth column the values of the 'lattice' energies calculated with London's[3] formula for a close-packed arrangement.

State	P	V	d	U	U_L	Zero point energy
Liquid	0	27·6	0·145	−14·3	−39	25
Liquid	25	23·25	0·172	−13·1	−52	39
Solid	25	21·2	0·189	−11·8	−62	50*

P in atm., V in c.c./mol., U in cal./mol.

* This value is in good agreement with the zero point energy calculated as $\frac{9}{8}R\theta$ with a Debye-θ of the appropriate density and temperature.

The seventh column gives the zero point energies obtained as the difference of columns 5 and 6. These figures serve to illustrate the precarious balance of forces deciding the fortunes of condensed helium. Needless to say, it would be of the greatest interest to obtain the corresponding data for helium 3, for which we shall have to look to America.

The melting of helium at absolute zero—and that means below about 1° abs. for all practical purposes—is a queer process. One cannot melt solid helium isothermally by supplying heat to the system—there is no heat of melting. Melting in this case is a purely mechanical process, similar to the lifting of a weight or the compression of an ideal spring. If we put condensed helium into a cylinder and push the piston down, we solidify it isothermally; if we extract the piston, we liquefy it. There are no entropy terms for the theoretician to worry about; but nevertheless the two phases show many of the characteristics of their normal counterparts. Although no one can pretend that the melting of helium at low temperatures is typical of normal conditions, a theoretical investigation of this apparently simpler process may well lead to a better understanding of the nature of melting.

[1] Simon, F. E., *Nature*, **133**, 529 (1934).
[2] London, F., *Proc. Roy. Soc.*, A, **153**, 576 (1936); *J. Phys. Chem.*, **43**, 49 (1939).
[3] See, for example, Hudson, R. P., Hunt, B., and Kurti, N., *Proc. Phys. Soc.*, A, **62**, 392 (1949).
[4] Keesom, W. H., Leiden Comm. 184*b* (1926).
[5] Simon, F. E., *Trans. Farad. Soc.*, **33**, 65 (1937).
[6] Holland, F. A., Huggill, J. A. W., Jones, G. O., and Simon, F. E., *Nature*, **165**, 147 (1950).
[7] Keesom, W. H., "Helium", 205 (Elsevier, Amsterdam, 1942).
[8] Keesom, W. H., *ibid.*, 332.
[9] Keesom, W. H., *ibid.*, chapter 4.
[10] Megaw, H. D., and Simon, F. E., *Nature*, **138**, 244 (1936). Megaw, H. D., *Phil. Mag.*, **28**, 129 (1939).
[11] See, for example, Simon, F. E., "Handb. d. Physik," **10**, 376 (Berlin, 1926). Rossini, F. D., and Jessup, R. S., *J. Research Nat. Bur. Standards*, **21**, 491 (1938).
[12] Bleaney, B., and Simon, F. E., *Trans. Farad. Soc.*, **35**, 1205 (1939).

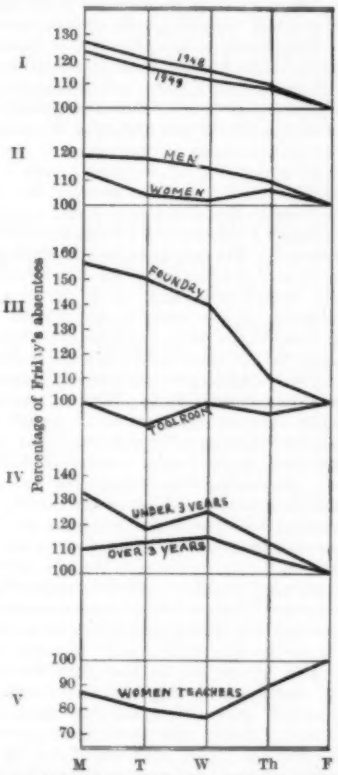
VARIATIONS IN ABSENTEEISM DURING THE WEEK: AN INDEX OF EMPLOYEE MORALE

By Dr. W. BALDAMUS and HILDE BEHREND

University of Birmingham

IN recent years employee morale has attracted much attention as an important factor in labour productivity. So far, however, this intangible factor has remained inaccessible to reasonably objective assessment. Attempts to measure morale by the usual variations in the rates of labour turnover, absence or output have failed, because all these indices are simultaneously affected by other factors such as earnings, working conditions, supervision and the worker's appreciation of leisure. As these other factors, however, do not vary from day to day, the following approach reduces the complexity of this problem to more manageable proportions. It consists, briefly, in comparing absenteeism on different days of the week and is based on the hypothesis that, owing to cumulative fatigue, the number of absentees in a factory should be expected to increase from Monday to Friday; if in reality the opposite happens, factors other than fatigue or working conditions (which do not change from day to day) must be involved, notably morale.

People with a low morale, those, for example, who dislike their job, will particularly dislike the return to work on the Monday (and stay away from work on Mondays) to a greater extent than those who are more satisfied with their work.



Variations of absenteeism during the week as a percentage of Friday's absentees. I to IV, industrial firm; V, grammar school

Our data are computed by counting the average number of absentees on each day of the five-day week and expressing them as a percentage of Friday's absentees, and are presented in Graphs I to V. No discrimination between time lost through sickness or through 'voluntary' absence is required. Nor is it necessary to use the number of employees as a basis for the index, as it would be in the case of the usual absence-rates. In the company of seven thousand employees whose factories we investigated first*, the resulting figures show a surprisingly regular pattern, namely, a steady decline in the average number of absentees from Monday to Friday, for example, Group I, in 1949: Monday, 123; Tuesday, 117; Wednesday, 112; Thursday, 108; Friday, 100. If these

* This research is being carried out under the auspices of the Research Board of the Faculty of Commerce and Social Science at the University of Birmingham. It is hoped that a monograph will be published on the whole problem of absenteeism.

variations are connected with morale, it would appear that morale is lowest on Mondays; as the week goes on, workers get more and more used to the daily grind of factory routine, and the degree of morale (and hence attendance) improves as pay-day and the week-end approach. We found that a smooth curve declining from Monday to Friday is obtained even when only a few weeks are taken to compute the daily averages of absentees, provided the sample is fairly homogeneous and not too small. In fact, the downward movement in absenteeism from Monday to Friday appears in almost every week throughout the year. The pattern becomes blurred only when the routine of factory and domestic life is broken by holidays, football matches, bus-strikes, etc. Other post-war years present a very similar picture, with the exception of 1946, when a six-day week was worked and Saturday ranked highest in absenteeism.

If the hypothesis is true that the pattern of day-by-day absenteeism is connected with morale, one would expect the slope of the curve to be different for specific categories of workers: the lower the morale of the group, and the greater the dislike of work, the steeper the downward trend of the curve. This was largely confirmed by a more detailed analysis of our material. For example, while there is a very steep, downward gradient for foundry workers (Monday, 157), skilled tool-room work shows a more or less horizontal, if not even rising, trend. Workers with less than three years service are characterized by a steeper fall of the curve than those with longer service. Some additional evidence in favour of our hypothesis was gained from data on average daily absence for women teachers at a girls' grammar school, where voluntary absenteeism was known to be insignificant, and morale, compared with factory standards, was expected to be high. When comparing the teachers' curve with those of the factory workers, it will indeed be observed that it is the only one where absence at the beginning of the week is lower than at the end. The increase in absence on Thursdays and Fridays may possibly indicate cumulative fatigue.

From overall absence and turnover statistics it is sometimes argued that women workers in factories have a lower morale than men. It came somewhat as a surprise, therefore, to find that the downward slope of the day-by-day absence curve is less clearly marked, and less regular, for women workers than for men. Does this mean that the morale of women at work is higher, in spite of the fact that the general level of their turnover and absence-rates are usually higher than those of men? Another company (with two thousand employees) situated in a different area and engaged on different work was investigated; but the result was the same: the women's curve, both for day and night shifts, was consistently flatter than the men's curve. When separate data for married and single women were collected, it was observed in both companies that the difference between average absence on Monday and Friday was smallest for married women, moderate for single women and largest for men. Until further details are available, the following tentative explanation is offered: women do not mind so much going back to the factory on Monday, since the week-end does not bring them true leisure but involves work as hard as in the factory, especially for the married woman who has to face an additional burden of housework during the week-end. On this point, our method might usefully be supplemented by attitude surveys conducted by means of questionnaires.

No doubt further research on such lines is required; but it is already clear that this approach to the problem of employee morale is more objective and offers more scope for comparing the level of morale of different firms, occupations and groups of workers within a given firm than any method based on interviews and questionnaires. At the same time, it permits a more direct and more reliable assessment of factors in motivation than is possible by means of overall turnover and absence-rates, which differ so lamentably in definition and method of computation between different firms. On the basis of day-by-day absence curves a way may be found even for international comparisons of the morale of workers in similar occupations, which hitherto has proved impracticable.

THE SHIRLEY INSTITUTE

THE British Cotton Industry Research Association, better known and more conveniently referred to as the Shirley Institute, or just plain "Shirley", was one of the earliest of the industrial research organisations to be established under the auspices of the Department of Scientific and Industrial Research. Now, after thirty years of existence, a "Year Book" has been published* for the purpose of explaining to the interested layman something of its history, its organisation, and what it has achieved. Reading through these pages, and looking back over so brief a period of time, it is astonishing to reflect on the great changes that have been wrought, not only in the Institute's physical growth, but also more especially in the outlook of Lancashire which it has played so large a part in shaping.

Intended to serve an industry based originally on hand craft, and which owed little to science for its development, the Association was faced at the start with a more than usually difficult task in justifying its existence. Though from the outset liberally assisted by the Department of Scientific and Industrial Research with government funds, its permanent survival required that it should become increasingly reliant upon the financial support of the industry itself. It had, therefore, to convince those who held the industrial purse strings, a majority of whom, if not actually hostile, were at least apathetic to the notion, that scientific research was an indispensable investment. Fortunately, there were among the leaders of the industry a sufficient number of influential men of enlightened views who were convinced that, without an infusion of the scientific spirit of progress, the industry was doomed to perpetual decline. By their efforts in the first place, the Association had come into being; and largely by their faith, energy and encouragement was it enabled to survive its early critical years. The debt the industry to-day owes to these men is incalculable. Thanks to the steadfast support of its successive Councils, to the wisdom of its successive directors of research, and to the solid worth of the work accomplished by its staff, the place of the Institute as a fully integrated part of the industrial structure of the cotton trade is now firmly established. A Lancashire cotton industry without a Shirley Institute is no longer imaginable.

* British Cotton Industry Research Association. Shirley Institute Year Book. Pp. 112+6 plates. (Manchester: British Cotton Industry Research Association, 1949.) 5s.

A large part of the early work of the Institute was devoted to instrumentation and to fundamental fibre study, the importance of which was far from apparent to the large numbers in the industry whose backing had sooner or later to be secured. The temptation to strive for more spectacular achievements by diverting attention to problems of immediate practical interest must have been strong; yet it was resisted. At the time it seemed that the necessity for building a sure foundation upon which further work could be based was justification enough. In retrospect, it is seen how the adoption of any other course might have ended in failure. The nature of the problems had not yet been specified in scientific terms; and furthermore, the staff of the Institute was not yet sufficiently versed in technology to invade the practical field on anything like equal terms with the manufacturer himself. Neglect of even one small practical feature of a situation could only too easily have brought forth amused contempt, if nothing worse, for these scientific workers who had come along to teach experienced mill-men how to do their jobs. The hope of establishing mutual confidence between the Institute and its member firms could have been irreparably shattered.

To-day that confidence is beyond question. Both the Institute and the industry have matured: the Institute in its understanding of practical problems as well as in its genuine respect for the knowledge and skill of the mill-man gained over many years of experience; the industrialists in their appreciation of the necessity for long-range fundamental research and in their recognition that research workers are humans like themselves, who, though differently trained and possessing different abilities, have their limitations and know it, are as glad as any other men to take advantage of informed criticism and advice, and are no less dedicated than they themselves to the task of increasing the prosperity of the industry they serve.

All this has not been accomplished merely by the passage of time, but by numerous acts of deliberate policy of which space here permits only the mention of two. At first the publications of the Institute were nearly all of the type appropriate to the journal of a learned society and for the most part beyond the patience, if not the comprehension, of those for whom they were intended. To remedy this, the more formal research papers were supplemented by a second line of printed communication, the *Bulletin*, now published six times a year, in which the progress and significance of current work are described in terms that the mill-man can rapidly read and readily understand. Excellently though the *Bulletin* serves its purpose, however, it was recognized that it could be no substitute for personal contacts. A Liaison Department was therefore set up, staffed by technologists with experience of industry, the function of which is to confer with mill-men on their own ground and in their own language, interpreting the work of the Institute to the industry, and bringing the problems of the industry to the research worker. In addition, the liaison staff spends an increasing proportion of its time in efficiency surveys of members' mills, the results of which, when collated and analysed by the more recently formed Technical Economy Section, are proving of the utmost value in reference to current problems of re-equipment and re-deployment of labour. Incidentally, it is worthy of wider acknowledgment that the technique of these surveys, devised and developed at the Institute so long ago as 1928, was extensively applied in various Service connexions during the War when all forms of 'operational research' received great attention.

This is not the place for reflexion on that part of the "Year Book" dealing with work in progress. Suffice it to say that by the quality and value of its work the Institute has established for itself a reputation among the research associations of Great Britain second to none, and that in the textile field there is no organisation elsewhere in the world that can even remotely be compared with it. In size as well as in influence it continues to grow. Though already several times larger in personnel and accommodation than it was at its foundation, it is still inadequate to carry out all it is called upon to do. An appeal has, therefore, recently been launched for funds to see it through the next large phase of its expansion. One could only wish that all those who set the Association upon its course were still alive to witness the raising of this monument to their vision and faith.

W. E. MORTON

THE HEBREW UNIVERSITY: TWENTY-FIVE YEARS OF ACHIEVEMENT

By PROF. S. BRODETSKY
President of the University

ON April 1, 1925, many thousands of people, including distinguished personalities, gathered on Mt. Scopus to witness a historic ceremony—the opening of the Hebrew University by Lord Balfour. At the time there was very little there; the hill was bare except for one or two old buildings, and the embryo university consisted in all of three small research institutes: chemistry, microbiology and Jewish studies. To-day, after twenty-five years, we are able to look back and assess what has been achieved in this dramatic quarter of a century, during which the fate and fortunes of the Jewish people have oscillated until the cycle has come round full circle.

It might be true that in comparison with the epoch-making discoveries and events which have taken place in other parts of the world, our achievements in Jerusalem have indeed been modest. Yet the value of the Hebrew University to the Middle East, where the light of higher education and culture had well-nigh been extinguished, cannot be over-estimated. The University has been a positive influence for good in the resurrection of Israel, by its wide contributions, among other things, to education, medicine, agriculture and industry. It has already proved itself a veritable blessing to the young State which it has staffed with large numbers of trained professional men.

From the modest beginnings described above, the University swiftly developed. To-day it has Faculties of Humanities, Science, Medicine and Law, a School of Agriculture (which will shortly be expanded into a full faculty), a Department of Social Sciences and Economics, a Department of Education, a University Press and the Jewish National and University Library with more than 500,000 volumes. 876 students have graduated from the University (473 in humanities, 366 in science, 37 in agriculture) and 103 doctorates have been awarded. This year the student enrolment has reached 1,541, the highest in

the University's history. The academic staff now numbers 237. This is one way of describing what has been achieved in these twenty-five years. To put it briefly, a fully-fledged University has emerged.

A statistical survey, though conveying the breadth of expansion, does not indicate its depth. Therefore, it will be useful to say a few words about some achievements in different sections of our University. Naturally enough, the Institute of Jewish Studies has come to assume a unique position in Jerusalem. Here ancient Jewish learning has been restored to its citadel in Zion in the framework of a modern university: Bible, Talmud, Jewish history, law, philosophy and Palestinography are approached in a scientific manner. There have been many discoveries, particularly in archæology, which have had a radical effect on the teaching of these subjects. But the important factor has been that these subjects could be studied in Israel, where they had their origins, where geographical data could be reconstructed, and where the natural phenomena, imagery and associations could be recaptured. This same geographical factor also gives the School of Oriental Studies a unique position; so Jerusalem has something special to offer in Jewish and Oriental studies.

On the science side, it was readily recognized that there were many other great universities with which it would be difficult to compete. Yet right from the beginning, the importance of science to the development of the country was emphasized by the founders. Dr. Chaim Weizmann, president of Israel and founder of the University, himself an outstanding chemist, stressed again and again that the sciences could not be neglected. So two of the three institutes that existed at the beginning of the University were science institutes, and I had the privilege of assisting in laying the foundation stone of the Einstein Institute of Mathematics and Physics also in April 1925. These twenty-five years have swept away the grave doubts that were then expressed as to whether a centre of scientific research could be built up in Jerusalem. The Hebrew University has been able to attract many scientific workers of world-wide reputation, such as Prof. Bernard Zondek (gynæcology and obstetrics); the late Prof. Halberstaedter (cancer research); Prof. F. S. Bodenheimer (zoology); Prof. Leo Picard (geology); Prof. A. Fodor and the late Prof. L. Farkas (chemistry). The University's men of science have certainly played their part in the romantic renascence of Israel and have done much to facilitate progress in agriculture through the studies of soil and climatic conditions, trees and plants, and methods of pest control. Industries have benefited considerably by their investigations in the field of applied research.

Perhaps one or two instances will enable the reader to grasp better the value of these scientific contributions to the country. The great key to "making the desert bloom" was the supply of water. Prof. L. Picard, head of the Geology Department, has been engaged during these twenty-five years in a determined effort to search out water in areas which have become arid and barren through the centuries. Thanks to him, ground-water was discovered at scores of points throughout the country where agricultural settlements have since been successfully established. In places like Matzuba, Kfar Kisch and Nahalal his name has become a legend. Each of these discoveries increased the absorptive capacity of Israel. In the ten years between 1937 and 1947, for example, this research made available an additional 6,750 cubic metres of water per hour, which enabled the production of tenfold the number of crops, and meant that the newly cultivated land could support approximately 50,000 people.

Medical research at the University has been mainly concerned with the endemic and epidemic diseases prevalent in the Middle East, such as malaria, typhoid, typhus and dysentery. The methods of immunization and control developed by the University scientific workers have reduced the incidence of the various diseases, particularly malaria, for which a research station was established at Rosh Pinah in the north many years ago.

The Government of Israel is planning to settle large numbers of immigrants in the Negev, which is a desert and semi-desert region in the south of Palestine. Last year the University's Botany Department set up a Desert Botanical Laboratory to study the flora of the region, to organise botanical collections of trees for afforestation, plants for decorative purposes, medicinal plants, plants for industrial uses, and pasture grasses, and to conduct research into the utilization of barren lands and sand-dunes. This research will have a definite bearing on the settlement of the area.

These three examples—from geology, medicine and botany—are typical of what could have just as easily been chosen from physics, chemistry, biology, or any other branch of science, where the same sort of record exists. This is the second way of describing what the University has so far achieved.

Only a university built on solid foundations would have been able to respond to the challenge which the sudden emergence of the State of Israel created. The Hebrew University came through this test successfully. First, it was able to place at the disposal of the Government a tried staff of first-class calibre. Prof. L. Picard was appointed head of the Government Geological Services; Prof. R. Bachi became Government statistician, Prof. S. Assaf a Chief Court Justice, Prof. S. Sambursky director of the Israel Scientific Research Council, and so on. Secondly, the University was able to open its Faculties of Medicine and Law so as to train medical men, judges, lawyers and Civil servants for the State. Thirdly, wherever any research has been required on current problems, the University has not been found wanting. At the present moment, its Department of Social Sciences, for example, is conducting research into the absorption of new immigrants. It has been able to broaden its adult education programme, which was already organised on a country-wide basis, to aid the cultural integration of new immigrants.

It is appropriate to add at this stage that much of the expansion has been accomplished in the past two years since the rise of the State of Israel, despite the fact that the University was compelled, by force of circumstances, temporarily to leave its home on Mt. Scopus and to set up in improvised quarters in the city of Jerusalem. This fact, perhaps more than any other, proves that the teaching and research work has been organised on such solid foundations that it could continue and expand even when the concrete edifice had become inaccessible.

These twenty-five years have shown us how to work as a University. They have convinced us that the possibility exists of doing great things in Jerusalem, not only for Jews but also for humanity, not only for Israel but also for science and scholarship and for the welfare of the world.

OBITUARIES

Prof. B. P. Babkin, F.R.S.

PROF. B. P. BABKIN, who died on May 3, was one of Pavlov's most distinguished pupils. He was a leading authority on the physiology of digestion, a careful experimenter with a comprehensive understanding of his subject, a clear writer and a modest and kindly man. Babkin was born in 1877 and began working with Pavlov in 1904 at the Military Medical Academy in St. Petersburg. Pavlov was then turning to the study of the central nervous system; but Babkin, as his first assistant, continued with the researches on digestion which had made the laboratory famous, and in 1914 he published a monograph on the digestive glands.

The troubles of the post-war years forced Babkin to leave Russia in 1922, and he spent two years at University College, London, with Prof. E. H. Starling. He was then appointed to the chair of physiology at Dalhousie University, Halifax, Nova Scotia, and afterwards to a research chair at McGill. Here he worked quietly and effectively until his retirement in 1942; and after that, in spite of a weak heart, he was still actively engaged in experimental work and in the re-editing of the monograph which had now become the authoritative text on the physiology of digestion.

In March of this year, Babkin was elected a Fellow of the Royal Society: he planned a visit to Britain this summer, and was looking forward to the renewal of old friendships; but he died suddenly from a heart attack on his way home from a scientific meeting. He will be remembered not only for his researches on digestion but also for the excellent biography of Pavlov which was published last year, and for the high standard of accuracy and clarity in all his work.

Mr. Thomas Rowatt, O.B.E.

THOMAS ROWATT'S directorship of the Royal Scottish Museum in Edinburgh, during 1933–44, crowned a life-time of labour in the service of that institution. He entered it as a young man of twenty-three in 1902, and the forty-two years which elapsed before he retired at the age-limit were marked by steady promotion and increasing responsibilities—assistant-keeper 1909, keeper 1921, director 1934. During these years he shared in the development of a new branch of the Museum's activities. In 1901 the then Edinburgh Museum of Science and Art was transferred from the Board of Education to the Scottish Education Department, and in the same year, under the directorship of Sir Francis Grant Ogilvie, the Technological Department was instituted with Dr. Alexander Galt, a former assistant of Lord Kelvin, as keeper. Mr. Rowatt was the first assistant in the new Department, a post for which he was well fitted by his varied training, in Frankfurt-on-Main, and in Edinburgh as an apprentice engineer and as an engineering student at Heriot-Watt College.

So Rowatt took part in the organisation of halls and galleries to illustrate the great industries—coal mining, the manufacture of iron and steel, civil and mechanical engineering; and since the Royal Scottish Museum has always prided itself upon the instructional value of its exhibits, the static collections were liberally interspersed with working models operated by hand or by electricity, and made in the Museum workshops. With a similar educational end in view, a school gallery was designed to illustrate physical and chemical concepts and the appliances suitable for their demonstration in science classes, and during the period of Rowatt's directorship a children's gallery was added to the Natural History Department. It was during his directorship also that part of the long-planned extension of the Museum was advanced by the building of the west wing, and this, apart from the development of the collections, enabled the miscellaneous specimens of models of ships, ancient and modern, to be re-arranged and expanded in a new and instructive shipping gallery.

During the Second World War the Museum was closed to the public for a time and used for other purposes, and on Rowatt fell the great responsibility of safeguarding an inflammable building and such treasures as had been retained in it. On its re-opening, still with educational possibilities in view, he developed the system of guide-lecturers and the organisation of temporary and highly popular exhibitions, which included, among others, Scottish fisheries, the utilization of rubber, Scottish everyday art, and Scottish birds and mammals.

Gifted with clear-cut ideas, determination, and a sense of organisation and discipline, Rowatt was appreciated by and popular with his staff and the many Museum visitors who came in contact with him. During the First World War he served with the engineers of the Royal Naval Division, and was awarded the Military Medal; in 1939 he was appointed O.B.E. Born in 1879, he died suddenly on April 7, and is survived by his wife, and a son and daughter, both graduates, the former in medicine and the latter in science, of the University of Edinburgh.

JAMES RITCHIE

Dr. F. T. Peirce

WE regret to record the death on April 11 in his native Australia of Frederick Thomas Peirce, who will long be remembered as a pioneer in the application of pure physics to the construction and testing of textiles. Peirce graduated from the University of Sydney in 1915 and then volunteered for service with the Australian Expeditionary Force, suffering severe wounds in Palestine. He came to Great Britain in 1918 under the terms of a Barker Graduate Scholarship and worked with Sir William Bragg at University College, London, on problems of X-ray powder spectrography. In 1921 he was appointed to a senior position in the Physics Department at the Shirley Institute, Manchester, and in 1924 became head of a new department. In 1931 the degree of D.Sc. by the University of Sydney was awarded to him for a thesis on the "Structure and Elastic Properties of the Cotton Hair".

During Peirce's twenty-four years in Manchester the Department of which he was the head grew steadily and provided not only important results of fundamental research work but also a large part of a valuable 'special investigator' service to members of the British Cotton Industry Research Association. His own publications included twenty-five memoirs, the importance of which to textile science was recognized by the award of the Warner Medal of the Textile Institute in 1946. The work provided such a mass of fundamental data on the relations between fibre, yarn and fabric structure and properties that Peirce and his colleagues were able to take up confidently an 'engineering' attitude to cloth design.

The outbreak of war in 1939 provided a unique opportunity to test this possibility. Cloths were required quickly for special purposes—parachutes, airmen's clothing, water tanks, arctic and tropical suitings—and the resources of the Shirley Institute were unreservedly devoted to meeting Service requirements. Peirce's own contributions came to the notice of the United States Quartermaster Corps, and in mid-1944, at their urgent request and by arrangement with the Ministry of Supply, he went to the United States to collaborate in the design of clothing for tropical jungle warfare. He very quickly made friends and was profoundly impressed by the possibilities for textile research there. The Americans on their part were impressed by his ability, range of vision and enthusiasm, and several inducements to remain in the States were soon forthcoming. Finally, at the end of 1944, he received a very attractive invitation—to become director of textile research in the School of Textiles, North Carolina State College. For years he had been pining for more sunshine and a climate more like that of his native country, and this offer decided him in favour of a change. After coming back to Great Britain to wind up his work there, he took up the appointment in 1945. The proximity of the College to cotton fields and to centres of cotton manufacture, and the opportunity to collaborate with a large teaching staff and with the keen investigators of the Quartermaster Corps, filled him with enthusiasm for the new venture; but, alas, very soon he had a stroke, from which he never really recovered. Pathetically, his family got him home to Australia, where he died, at the age of fifty-three, leaving a widow and three daughters.

Peirce was certainly one of the leading physicists in the field of textile research, and he was also a charming and inspiring colleague, and a good friend and neighbour. His loss is a great blow to all his associates and not least to the present writer, with whom he worked in happy friendly contact for fourteen years.

F. C. Toy

NEWS and VIEWS

The Royal Society: Foreign Members

The following have been elected foreign members of the Royal Society: Dr. W. S. Adams, Prof. Carl F. Cori, Prof. E. Fermi and Prof. Carl Skottsberg.

Dr. W. S. Adams

Dr. Walter Sydney Adams began his astronomical career in 1898, attached to the staff of the Yerkes Observatory as a Fellow in Astronomy. Six years later he accompanied Dr. G. E. Hale as one of the staff of the Mount Wilson Observatory, of which he became director in 1923 in succession to Hale. He was a source of inspiration for many years of most fruitful research at that Observatory, and since his retirement from a post with such heavy administrative duties he has returned with renewed vigour to the joys of spectroscopic research. He was elected an associate of the Royal Astronomical Society in 1914 and was awarded its Gold Medal in 1917 for his investigations in stellar spectroscopy, including the determination of absolute magnitude. He has been throughout an active member of the International Astronomical Union and was vice-president during 1935–48; the Union is indebted to him for keeping it working so far as possible during the difficult years of the Second World War. He has made magnificent use of the opportunities that have been his to study high-dispersion stellar spectra; mention must be made of his pioneer work on spectroscopic absolute magnitudes, his study of the laws of solar rotation at different levels in the sun's atmosphere, his work on interstellar *H* and *K* lines of complex structure, his calibration of Rowland's scale of intensities for solar lines, his examination of the spectra of novæ and his work on early-type stars and their radial velocities. There are, in fact, very few branches of stellar spectroscopy to which he has not made major contributions. His many friends will be delighted at this most recent recognition of the importance and wide range of his astronomical researches.

Prof. Carl F. Cori

The election of Prof. Carl F. Cori to foreign membership of the Royal Society will give satisfaction to biochemists throughout the world. His work has been mainly carried out in collaboration with his wife, Dr. Gerty T. Cori, and they shared one half of the Nobel Prize for Medicine in 1947. The research work of this distinguished pair shows, throughout the thirty or so years in which they have been working, a logical thread and unity which is rare in any field but particularly so in that of biochemistry. In the early 1920's, the Coris investigated the carbohydrate balance of animals, particularly that of the rat, and the influence thereon of hormones, such as adrenaline and insulin. Their eponymous cycle, whereby blood glucose undergoes conversion first to muscle glycogen, then to blood lactic acid, to liver glycogen and so back to blood glucose, was an important outcome of this work. They then turned their attention to the investigation of the enzymes in liver and muscle concerned in glycogen formation and breakdown. This quickly led to the isolation, characterization and synthesis of glucose-1-phosphate, a key substance in the intermediary metabolism of glucose. Isolation of the enzyme phosphorylase followed, and a distinction was drawn between phosphorylase *a* and phosphorylase *b*. Their discovery, in 1939, that phosphorylase will act on glucose-1-phosphate *in vitro* under suitable conditions to give polysaccharides resembling glycogen and starch was a magnificent outcome of this aspect of their work, and provided the first example of the *in vitro* synthesis of a polysaccharide. This discovery may be said to be a turning point in the development both of carbohydrate metabolism and of polysaccharide chemistry.

Turning once more to the influence of hormones on metabolic processes, the Coris have recently investigated the action of hormones on enzyme systems *in vitro*, and, although many results have been largely negative, the effect of anterior pituitary extracts and insulin on hexokinase activity *in vitro*, which they observed, has been confirmed under the conditions which they described. On the other hand, experiments with enzymes and hormones *in vitro* are so often uncertain that the Coris have now turned to the examination of the activity of enzymes obtained from an animal which has been treated

with hormones *in vivo*, and to the examination of the responses of intact tissues, such as rat diaphragm, *in vitro*.

Prof. E. Fermi

PROF. Enrico Fermi, of the University of Chicago, is one of those rare physicists who is a leader both in the fields of abstract theory and of experimental technique. His many important contributions to modern physics include the statistical law applied to particles obeying the exclusion principle, the quantitative theory of β-transformations of nuclei, the discovery of artificial radioactivity induced by neutron bombardment and the improvement in efficiency of this process by the slowing down of neutrons. Fermi moved from Rome to the United States in 1939 and was associated with the American atomic energy project from its beginning. His imagination, ingenuity and drive was very largely responsible for the successful completion of the first chain-reacting pile at Chicago in 1942. He is now working at the Institute of Nuclear Studies, Chicago. This list by no means exhausts the subjects to which Fermi has made contributions of decisive importance, nor does it include his indirect contribution to physics through the pupils to whom he has often succeeded in imparting some of that particular combination of sound intuition with simplicity of reasoning which is his strongest asset.

Prof. Carl Skottsberg

PROF. CARL SKOTTSBERG was born on December 1, 1880. His first botanical paper appeared in 1900, and since that year he has been actively engaged in researches on plant life. His publications number about 250 and cover a wide range of subjects, particularly in systematics and plant geography. Very early in his career, Prof. Skottsberg turned his attention to Antarctica and southern South America. Not only did he prepare many of the botanical accounts of the Swedish South Polar (or Antarctic) Expedition (1901–3) and the Swedish Expedition to Patagonia and Fuegia (1907–9), but also the latter was arranged by him. A summary of the botanical results, with bibliography, of these two expeditions was published in the *Kew Bulletin*, 268–79 (1919). Of wide general interest were his investigations on the flora and vegetation of Juan Fernandez, the Falklands, South Georgia and Graham Land. In a very readable book ("The Wilds of Patagonia", Edward Arnold, London, 1919) Skottsberg gives a general account of his travels on the mainland of Temperate South America. Later, he extended his researches to the Pacific islands by visits to Easter Island and Hawaii. In many papers he has dealt with the taxonomic and phytogeographical problems of their isolated flora. He has, however, always maintained his interest in the large area of his earlier field studies. His work throughout has mainly been concerned with the flowering plants and the brown seaweeds; but following on the results of his systematic researches, he again and again links these with the wide problems of plant distribution. Prof. Skottsberg was elected a foreign member of the Linnean Society of London in 1943, and an honorary fellow of the Royal Society of Edinburgh in 1949. He is president designate of the Seventh International Botanical Congress to be held in Stockholm in July this year. He retired from the directorship of the Göteborg Botanic Garden on December 31, 1948.

UNDER the statute of the Royal Society which provides for the election of persons who either have rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society, Dr. G. M. Trevelyan, master of Trinity College, Cambridge, has been elected a Fellow of the Society.

American Academy of Arts and Sciences: Foreign Honorary Members

THE following have recently been elected foreign honorary members of the American Academy of Arts and Sciences: Henri Cartan, professor of mathematics, University of Paris; Sir John Cockcroft, director, Atomic Energy Research Establishment, Harwell; P. A. M. Dirac, professor of mathematics, University of Cambridge; W. Pauli, professor of theoretical physics, Swiss Federal Institute of Technology, Zurich; E. Schrödinger, senior professor, Dublin Institute for Advanced Studies; G. C. de Hevesy, associate professor, Institute of Research in Organic Chemistry, University of Stockholm; Adolph Meyer, chief engineer, Brown Boveri and Co., Ltd., Baden; H. G. Lundegårdh, professor of plant physiology and director, Institute at Lantbrukshögskolan, Uppsala; K. U. Linderström-Lang, director, Carlsberg Laboratory, Copenhagen; R. A. Peters, professor of biochemistry, University of Oxford; Hugo Theorell, of the Medical Nobel Institute, Stockholm; W. G. Penfield, professor of neurology and neurosurgery, McGill University.

Unesco Science Co-operation Office for Latin America

As an outcome of the Latin-American conference for the development of science, held in Montevideo in September 1948, the Unesco Science Co-operation Office for Latin America was opened in Montevideo a little more than a year ago. In his survey of the first year of its activities, the head of the Office, Dr. A. Establier, reports that the start was very successful. Requests for scientific liaison have been steadily increasing. The Office has been asked to assist in many hundreds of problems and has supplied bibliographies, scientific literature, type cultures, etc., and, generally, information on subjects touching on every branch of science. Among the publications of the Office may be mentioned "List of Scientists and Scientific Institutions in Latin America", four volumes of which have now been published, and "List of Latin-American Scientific Papers published during 1948" (see *Nature*, April 15, p. 589). The Office has initiated the creation of a centre for the study of cosmic radiation and high-altitude physics at Morococha, Peru (4,500 m. above sea-level), which should become an important centre for such research, not only for Latin America, but of interest also for scientific workers from other parts of the world. It has also sponsored the first Latin-American conference on marine biology in Valparaiso, Chile, has collaborated with the Government of Peru in organising the symposium on high-altitude biology, recently held in Lima, and has stimulated the formation of new scientific societies. Through the Office, Latin-American men of science have also given valuable help to other countries; for example, when the maize-fields of the Philippines were ravaged by insect pests, seeds of more resistant varieties of maize were forwarded, and these are now being successfully grown there on an experimental basis. Plans have been worked out for

a scientific museum in Montevideo; and a mobile exhibition will shortly tour the Latin-American countries and will show different aspects of science and its relation to daily life. In his report Dr. Establier points out that a characteristic of the work has been the complete collaboration that government and scientific institutions and individual men of science have shown, and he is of the opinion that this true Unesco spirit which he has found over the whole continent of South America is most promising for the future. The address of the Office is: Unesco Centro de Cooperación Científica para América Latina, Bulevar Artigas 1320, Montevideo, Uruguay.

Theory of Relativity in Contemporary Science

THE seventieth birthday of Prof. A. Einstein was celebrated in Princeton on March 19, 1949, by the reading of a group of papers with the title "The Theory of Relativity in Contemporary Science", and these have now been published (*Proc. Amer. Phil. Soc.*, 93, No. 7, 521; 1949; 50 cents). E. P. Wigner deals with invariance in physical theory, distinguishing between the older types of invariance which found perfect formulation in the special theory of relativity, and the new type, not yet completely understood, corresponding to the general theory of relativity. A somewhat similar distinction is drawn by H. Weyl, who deals with the stimulus of relativity theory on pure mathematics, particularly with invariance, the theory of groups and differential geometry. In these the most valuable suggestions for developing general ideas have come from the general theory of relativity, though these are much more complicated than those arising from the special theory. G. M. Clemence explains some new methods for applying relativity theory to the motion of the planets; the application to the perihelion of Mercury is well known, and there is now good hope of dealing with the earth, Mars, possibly Venus, and some minor planets. A much more difficult problem, that of relativistic cosmology, is discussed by H. P. Robertson. After recalling the cosmological theories of Einstein, Weyl, Friedmann, Lemaître, Tolman and himself, leading up to Hubble's idea of an expanding universe, Robertson gives a critical examination of the evidence. He concludes that we have not yet sufficient data and must look forward to the facts which may be provided in the near future by the 200-inch telescope on Mount Palomar.

Mode of Action of Insecticides

THE Chemical–Biological Co-ordination Centre of the National Research Council, Washington, D.C., was established in 1946 with the object of assembling information on the relation of chemical structure to biological activity, to sponsor the 'screening' of chemicals for their biological effects, and to prepare reviews of the literature on test methods and biological activity. Review No. 1 has now been published (pp. 84; 1948; 1 dollar). It deals with the mode of action of organic insecticides, exclusive of fumigants, and covers both natural products such as the pyrethrins, rotenone and nicotine and such synthetic insecticides as benzene hexachloride, DDT and the organic phosphates. The chemistry of the active substances is outlined, and what is known of their mode of entry and the points at which they interfere in the normal physiology of the insect are reviewed. It must be admitted that much of the existing knowledge is very incomplete or appears contradictory. But the review, which is by R. L. Metcalf, of the Citrus Experiment Station in California, is a very competent piece of work and will prove a valuable starting-point for anyone wishing to make a scientific study of insecticides.

British Journal of Sociology

THE re-appearance of a journal devoted to the publication of recent researches in sociology has been long expected. More and more investigators have been concerned with sociological matters, and now the London School of Economics has provided them with a medium in which the results of their observations can be expressed. Edited by Profs. M. Ginsberg, D. V. Glass and T. H. Marshall, the first issue contains articles by Prof. R. Aron on "Social Structure and the Ruling Class"; Prof. D. V. Glass on "The Application of Social Research"; J. Hall and D. Caradog Jones on "Social Attitude and Social Class"; and Asa Briggs on "Social Structure and Politics in Birmingham and Lyons". There are also an extensive list of book reviews and a short section dealing with current events in sociology. The format of the journal is good. Publication will be quarterly. In order to attract the widest possible circle of readers it is hoped that articles describing some of the sociological investigations being carried out in various industrial organisations and in the Services may be included.

Basil Hicks Lecture of the University of Sheffield

THE fourth Basil Hicks Lecture of the University of Sheffield will be given by Lord Boyd-Orr on November 10. The Basil Hicks Lecture was founded by the late Dr. William Hicks, formerly principal of Firth College and University College, Sheffield, and charter vice-chancellor of the University of Sheffield, in memory of his son who was killed in the First World War. The foundation provides for a triennial lecture dealing with some aspect of the First World War, either in its origins, its conduct or its social and international consequences, or such other subject of national or international interest as may be arranged. Previous lecturers have been Mr. H. A. L. Fisher, Dr. Gilbert Murray and General J. C. Smuts.

University of Birmingham: Recent Appointments

PROF. E. A. Peel, at present professor of educational psychology in the University of Durham, has been appointed professor of education and head of the Department of Education, University of Birmingham. The following appointments in the University have also been announced: D. H. Griffiths to be lecturer in geophysics; G. L. Hatherley to be lecturer in metalliferous mining; Dr. A. Lasnitzki to be senior research fellow in biochemistry (cancer research); and Dr. D. L. Woodhouse to be lecturer and senior research fellow in chemical pathology.

Institute of Chemistry of Ireland: Election of Officers

AT the first annual general meeting of the Institiuid Ceimice na hEireann (Institute of Chemistry of Ireland), the following officers were elected: *President*, Dr. A. G. G. Leonard; *Vice-President*, W. V. Griffiths; *Honorary Secretary*, F. T. Riley; *Honorary Treasurer*, M. Cranley; *Council Members*, Dr. V. Barry, D. Crowley, Prof. T. Dillon, D. T. Flood, G. F. O'Sullivan, Prof. T. S. Wheeler and G. Martin Wheeler (*Secretary*). The meeting stressed the contribution which the chemist can make to efficiency

in industrial production, and it was noted with regret that this fact is apparently not appreciated by the Government of Eire. No chemist has been appointed to either the Irish Industrial Development Council or the Council of Education, although the members of that Institute feel it should be obvious that many matters coming before these bodies for consideration deal with subjects in which the advice of a properly qualified and experienced chemist would be invaluable.

Institute of Petroleum : Officers for 1950–51

OFFICERS of the Institute of Petroleum for the year 1950–51 have been elected as follows. *President :* C. A. P. Southwell, managing director, Kuwait Oil Co., Ltd. *Vice-Presidents :* M. A. L. Banks, manager of operating branch, Refining Division, Anglo-Iranian Oil Co., Ltd. ; E. J. Dunstan, director, Manchester Oil Refinery, Ltd. ; Prof. F. Morton, professor of chemical engineering, University of Birmingham ; J. S. Parker, refinery manager, Lobitos Oilfields, Ltd. ; H. C. Tett, general sales manager, Anglo-American Oil Co. *Honorary Secretary :* C. Chilvers, manager, Costs and Operations Department, Anglo-American Oil Co., Ltd. *Honorary Treasurer :* G. H. Coxon, Anglo-Iranian Oil Co., Ltd.

Colonial Service : Recent Appointments

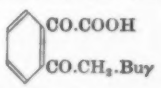
THE following appointments in the Colonial Service have recently been announced : R. W. Kettlewell (senior agricultural officer, Nyasaland), deputy director of agriculture, Nyasaland ; C. J. McGregor (senior agricultural officer, Tanganyika), regional assistant director, Tanganyika ; B. G. Montserin (cocoa agronomist, Trinidad), chief scientific officer, Trinidad ; A. V. W. Ping (assistant agricultural superintendent, British Guiana), agricultural superintendent, British Guiana ; G. M. Rodhan (deputy director of agriculture, Kenya), director of agriculture, Nyasaland ; N. V. Rounce (senior agricultural officer, Tanganyika), regional assistant director, Tanganyika ; A. H. Savile (senior agricultural officer, Tanganyika), regional assistant director, Tanganyika ; H. P. Smart (senior agricultural officer, Tanganyika), regional assistant director, Tanganyika ; A. F. Barker, lecturer in physics, Yaba Technical Institute, Nigeria ; J. A. F. Russell, lecturer in mechanical engineering, Yaba Technical Institute, Nigeria ; K. Welding, assistant engineer, Public Works Department, Federation of Malaya ; J. W. Henderson, assistant conservator of forests, Gold Coast ; G. Jefford, chemist assayer, Nigeria ; E. P. Wells, veterinary officer, Uganda ; R. I. G. Attwell, biologist, Northern Rhodesia ; R. J. B. Power, field zoologist, tsetse fly survey and control (Veterinary Department), Kenya ; C. H. Sharpston, statistician, East Africa High Commission.

The Night Sky in June

NEW moon occurs on June 15d. 15h. 53m., U.T., and full moon on June 29d. 19h. 58m. The following conjunctions with the moon take place : June 6d. 17h., Jupiter 2° N. ; June 12d. 08h., Venus 6° S. ; June 13d. 17h., Mercury 8° S. ; June 21d. 23h., Saturn 0·4° N. ; June 23d. 11h., Mars 0·4° N. Mercury is a morning star but is too close to the sun to be easily observed. Venus, a morning star, rises at 2h. 30m., 2h. 10m. and 1h. 55m., at the beginning, middle and end of the month, respectively, and can be seen for a short period before sunrise. Mars sets at 1h. 20m. and 23h. 40m. on June 1 and 30, respectively. On June 22 the planet has the same Right Ascension as η Virginis and is a little more than 1° south of the star in Declination. Jupiter rises at 0h. 50m. on June 1 and at 23h. 00m. on June 30, and can be seen for a few hours before sunrise in Aquarius. The planet is stationary on June 27, after which its motion is retrograde. Saturn, in the constellation of Leo, sets at 1h. 05m., 0h. 10m. and 23h. 15m. on June 1, 15 and 30, respectively. No occultations of stars brighter than mag. 6 occur in June. Summer solstice is on June 22d. 00h.

"Indenone-Carboxylic Acids and *allo*-Dunnione"

THE communication under this title by R. G. Cooke and T. C. Somers, published in *Nature* of February 25, p. 314, contains two printing errors. The structural formula (II) should read as follows :



Also, in line 2 of the last paragraph the name of the compound produced was 2-*iso*-propyl-indanone-3-carboxylic acid (m.p. 103–104°), not . . . indenone . . . as printed ; the 'anone' ending applies only in this one instance.

Announcements

THE Osler Memorial Medal for 1950 of the University of Oxford has been awarded to Sir Ernest Kennaway, emeritus professor of experimental pathology in the University of London.

MR. DENIS RICHARDS, author of the earlier half of the R.A.F. "short" Official History soon to be published, is to succeed the late Mrs. Eva Hubback as principal of Morley College for Working Men and Women, Westminster Bridge Road, London.

THE following appointments in the University of Leeds have recently been announced : Dr. R. A. Willis, director of the Pathology Department, Royal Cancer Hospital, London, to the chair of pathology ; and Dr. F. S. Dainton, H. O. Jones lecturer in the Department of Physical Chemistry, Cambridge, to the chair of inorganic and physical chemistry.

PROF. W. HAMILTON WHYTE, professor of economics in the University of Bristol, has been appointed director of the Institute of Social and Economic Research at University College, Ibadan, Nigeria. He will take up his duties in September next. The Institute, like that at Makerere College, East Africa, under the directorship of Dr. Audrey Richards, and the Institute at the University College of the West Indies, under Dr. H. D. Huggins, will initiate and co-ordinate research in the social sciences with special reference to local conditions.

HONORARY associateships of the Birmingham Central Technical College have been conferred on the following : Mr. Frank G. Woollard, director of the Midland Motor Cylinder Co., Ltd. ; Mr. J. W. Donovan, joint managing director of the Donovan Electrical Co., Ltd., and chairman of the South Midlands Branch of the Institution of Electrical Engineers ; Mr. T. H. Gant, chief engineer of British Industrial Plastics, Ltd. ; and Dr. M. Cook, research director of the Metals Division of Imperial Chemical Industries, Ltd., and president of the Institution of Metallurgy.

ANOMALOUS RATES OF BURNING IN CORDITE

By J. D. HUFFINGTON
Royal Aircraft Establishment

THE structure of the reaction zone in a flame has been investigated theoretically by Boys and Corner[1]. Their results apply when the flame is consuming solid, liquid or gas at a steady rate, and it is assumed that the original surface of the burning substance is continually renewed. In other words, their theory applies when equilibrium conditions exist. As an example, we may take the case of an organic compound such as cordite undergoing primary decomposition in the solid and producing a flame, the surface receding at a steady speed of the order of 1 cm./sec.

Another type of decomposition, entirely different from the foregoing but not unrelated to it, is the very slow thermal decomposition of such a compound *in vacuo* or in the presence of its own gaseous products when maintained at a temperature of, say, 150° C. for a long time. This decomposition is in general complicated by the existence of both bulk phase and preferential surface decomposition. A considerable amount of work has been done in applying this technique to the study of the kinetics of decomposition. The nature and quantities of the gases evolved give important information.

In a forthcoming paper the region between the two extremes of steady burning and slow thermal decomposition is considered. In the case of cordite, it is possible to realize conditions in practice such that decomposition is so fast as to prevent any bulk-phase heating, but still not fast enough to establish steady burning. In these circumstances, it is found that intermediate decomposition products may be produced on the surface, thus forming a stable layer which determines to a large extent the future course of decomposition. Only with solids could the nature of the surface play such an important part, and other examples of a somewhat analogous nature are known (for example, oxidation passivity in metals).

If the solid substance undergoing decomposition is inhomogeneous, as is the case, for example, with cordite containing nitroglycerine and nitrocellulose, the stable surface resulting from partial decomposition shows certain structural features by a process resembling thermal etching. Information not readily revealed by unburnt cordite is in this way obtained. For example, both a coarse and a fine structure have been discovered. The fine structure appears to be due to the existence of nitroglycerine particles of about 1·8 microns diameter embedded in a continuous matrix of nitrocellulose, these particles forming into groups or colonies which have a higher nitroglycerine content than elsewhere. The colonies or cells are about 15 microns in diameter and their presence is shown in Figs. 1 and 2, which represent successive stages of surface decomposition. The overall structure appears to be rather similar to that of a copper–silver eutectic with nitroglycerine in place of the copper and nitrocellulose in place of the silver. Fig. 3 is a photomicrograph (reflected light) of a rough unburnt cordite surface which just shows the particles of 1·8 micron diameter. The rough surface was produced by scraping with a sharp steel dge.

The equipment which has been used for studying this phenomenon consists of two rectangular blocks (say 3 in. × 0·7 in. × 0·7 in.) of cordite held facing one another in the centre of the combustion chamber. A narrow parallel-sided or wedge-shaped gap of order 1/40 in. wide remains between the blocks, but the walls of the chamber do not approach nearer than about one inch from the cordite surfaces outside the gap. An auxiliary charge of cordite is arranged to fill the combustion chamber suddenly with the gaseous products of normal burning at a temperature of order 2,500° K. and pressure of order 30 atmospheres.

Burning of the two surfaces parallel to the gap surfaces is inhibited by coating with a suitable non-

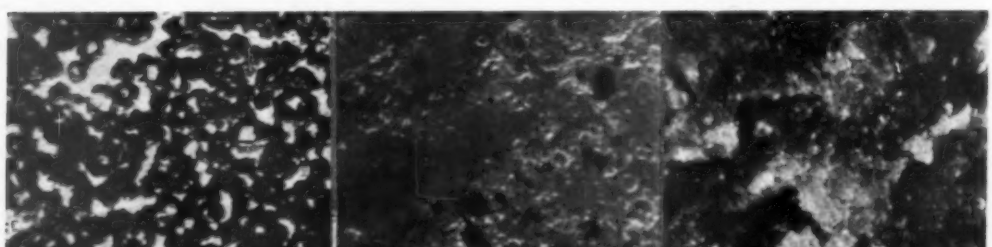


Fig. 1. Blackening of an originally smooth unburnt cordite surface produced by retarded burning inside a gap. (× *c.* 130)
Fig. 2. Appearance of surface shown in Fig. 1 immediately after the sudden disappearance of the black deposit, showing cells *c.* 15 μ diam. (× *c.* 120)

Fig. 3. A roughened surface of unburnt cordite (main constituents nitroglycerine and nitrocellulose) showing particles *c.* 1·8 μ in diam. (× *c.* 200)

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burning material. The surfaces at right angles to the gap surfaces burn steadily in the normal way as soon as equilibrium is established (this occurs very rapidly). A suitable arrangement is used for suddenly interrupting burning after different predetermined times ranging, say, from 0 to 0·2 sec. from the start of burning. The corresponding distances of recession of the sample faces can be measured with a micrometer, or by more accurate means.

It seems that the surfaces inside the gap do not burn at a constant rate. The burning-rate is alternately explosively high and nearly zero. Visual and microscopical observation of the surface shows clearly that the zero burning-rate is caused by clogging of the surface with some relatively stable decomposition product. The latter grows in concentration during the explosive stage of decomposition, and when it covers a certain surface area decomposition ceases. The black deposit in Fig. 1 is an example of this type of clogging. After a time, the burning-rate again becomes explosively high and the surface deposit immediately disappears, to be replaced later by another decomposition product of increased stability. Fig. 2 represents the surface appearance immediately after the disappearance of the black deposit of Fig. 1.

The wedge-shaped gap experiments show that the behaviour is fundamentally as stated above at all positions along the wedge, although the process is more advanced after a given time at the wide end of the gap than at the narrow end.

The explanation of the abnormal behaviour inside the gap is fairly simple, and there seems little doubt that the basic cause is the limited amount of energy available inside the gap for decomposing the cordite surfaces.

Assuming the Boys–Corner theory to apply to the normal burning process, steady burning would be maintained by the conduction of heat back to the cordite surface through a reaction zone in the gas phase close to the surface. A series of reactions occurs after the molecules are liberated from the surface, and the gas temperature rises from a minimum at the surface to a maximum at a small distance from the surface. During the initiation of burning and before equilibrium is reached, the reactions cannot proceed unless the temperature rises; and the temperature cannot rise unless the reactions proceed, so that the reaction zone is built up in a finite time. Inside a gap, conditions are abnormally unfavourable to the attainment of equilibrium because the cold molecules from the initial surface reactions tend to accumulate, monopolizing the available space and pushing other molecules out before they can react, thus providing thermal insulation to the gap surfaces and to the gas trapped inside the gap. Also conditions are likely to be less turbulent inside a gap than outside; this will tend to keep down the reaction-rate between molecules in the gas phase. Additional energy required to decompose stable intermediate products at the surface may have to be built up gradually by a process of secondary reaction in the gas phase inside the gap, or by thermal conduction or diffusion from the hot gases outside the gap.

The results obtained with parallel-sided and wedge-shaped gaps were similar, the main difference being that retardation of burning was much more marked with a parallel-sided gap. In the latter case, the time from the start of burning and the distance of recession of the gap surface at which a given chemical transformation occurred were both greater than with a wedge-shaped gap. It is thought that the reason for this is the existence of a smaller degree of turbulence with parallel-sided gaps, thus reducing the reaction-rate in the gas inside the gap. As a consequence of these facts, the 'resolving' power of parallel-sided gaps is greater than that of wedge-shaped gaps, so that some additional discontinuities were found in the former case.

It is possible that this technique may prove useful in investigating the kinetics of decomposition of combustible solids like cordite, or even of solids which only burn in an oxidizing atmosphere. The way in which structural features are revealed by the retarded decomposition may also be of value. In the case of cordite, there is evidence (given in the forthcoming paper) that steady burning really consists of a series of explosive surface recessions of order 3 microns, and the results with retarded burning support this view. The 3-micron distance is probably related to the structure of the cordite, and is possibly the distance between adjacent nitroglycerine globules in the nitrocellulose matrix.

This communication is based on work carried out in the Ministry of Supply, and I am indebted to the Chief Scientist and to the Controller H.M. Stationery Office for permission to publish it. The photograph shown as Fig. 2 was obtained by Dr. R. N. C. Strain, of the Royal Aircraft Establishment, Farnborough. The views expressed are my own and not those of the Ministry.

[1] Boys, S. F., and Corner, J., *Proc. Roy. Soc.*, A, **197**, 90 (1949).

POLYPLOIDY IN RABBITS, INDUCED BY COLCHICINE

By Prof. GÖSTA HÄGGQVIST
Dept. of Histology, Karolinska Institutet, Stockholm
AND
ALLAN BANE
Veterinary Highschool, Stockholm

THE experimental production of polyploid breeds of different plants extended the possibilities of plant-breeders in a way previously undreamt of; it was attained in two different ways, by temperature shock or by means of chemical agents. Of these two methods the temperature shock is the earlier. It appears to have been first applied to *Datura* and other plants by Belling[1] in 1925, who found that low temperature during meiosis resulted in doubling of the chromosomes. In 1932 Randolph[2] exposed the grain of maize to a temperature of 38°–45° C. Then in 1936 Schlösser carried out experiments on the 'cold treatment' of turnips, whereby he produced polyploids in 8–13 per cent. Far more important for plant-breeding, however, were the possibilities soon afterwards afforded for the use of chemical agents—in the first place colchicine. This method was first introduced by Blakeslee[3]. Although a number of other chemical substances have been found serviceable for the purpose, colchicine has nevertheless still maintained its leading position in plant-breeding.

The production of polyploids of animals has been an entirely different matter. Attempts have been made to introduce colchicine treatment shortly after fertilization. At this point, however, it has been found impossible to bring the egg into contact with

the alkaloid, as the latter cannot penetrate the coverings surrounding the eggs. Investigators have therefore largely abandoned the colchicine method, resorting, instead, to temperature shock. The first to adopt the latter treatment seems to have been Gross[4], who exposed eggs of prawns (*Artemia salina*) in the first maturation division to cooling. The method has since been applied to vertebrates (frogs and toads) by Rostand[5], Griffiths[6] (*Triturus*), Fankhauser[7], and others.

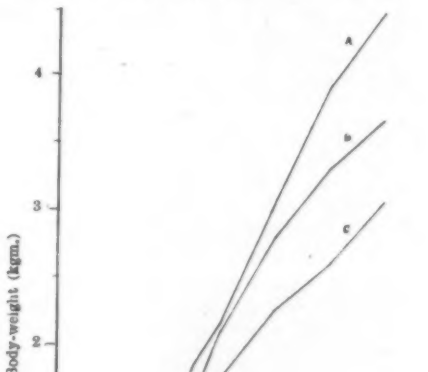
In 1948 one of us (Häggqvist[3]) reported the production of tetraploid forms of the common frog (*Rana temporaria*) by letting fertilization proceed in a weak colchicine solution. The resulting larvæ showed giant growth, but also a number of malformations in bodily structure, pigmentation, etc. We did not succeed in keeping any of them alive beyond metamorphosis.

The first experiments on mammals were made by Pincus and Waddington[8]. They treated recently fertilized rabbit eggs with dilute solutions of alcohol, ether and colchicine, and found that the last-mentioned agent hindered the development of the spindle, besides retarding or completely preventing the cleavage of the cytoplasm. In Waddington's laboratory, Beatty and Fischberg[10] have recently (1949) subjected tubal eggs of mice to cold- or heat-treatment *in situ*, and have obtained diploid, triploid and tetraploid forms. Altogether twenty-two eggs were undoubtedly heteroploid in stages up to the blastula. Many eggs, however, developed normally.

With the adoption, in essentials, of the method that Häggqvist had applied to frogs, we have treated rabbits with colchicine. The first of these experimental series is now about six months old. The young are the result of a cross between a large (♂) and a small (♀) 'silver-rabbit' breed. The buck weighed 4·120 kgm., the doe 2·600 kgm. The young were born on June 8, 1949, in a litter of seven individuals. Two of the young died after seven and eight days, respectively, one after thirteen and one after fifty-three days. The other individuals (two of which are males and one a female) have developed well. They show no deviations from the normal bodily form. In regard to colour, their appearance is also similar to that of the parents.

In determining the degree of polyploidy, a chromosome count can scarcely be considered in this case. Beatty has recently[10] suggested a method of measuring 'the mean nucleolar area' in epidermis cells. A somewhat similar proposal of Fankhauser[7], namely, measuring the nuclear area in epidermis cells, is of earlier date (1938). These methods cannot very well be applied to mammals. A simpler procedure, it seemed to us, was to determine the cellular or nuclear area in suitable organs. In such cases, however, it should be borne in mind that most cells, or cell nuclei, in the animal organism are subject to marked changes in volume in connexion with the functional rhythm. A liver cell, for example, may show considerable fluctuations in volume (Forsgren). Even if we compare cells taken at the same time from two different individuals, we cannot be certain that they are at exactly the same stage of diurnal rhythm.

A cellular form that seems to us to meet every requirement in this respect is the erythrocyte. Griffiths[6] states that in triploid *Triturus* the erythrocytes were larger than normal. So far as we know, they are not subject to any functional or rhythmical fluctuations in volume. A blood sample can very easily be taken. We have made blood smears so thin that each cell lay isolated, without being deformed by its neighbours, or being covered by the latter. The preparation was allowed to dry in air, whereupon the cells at a magnification of 1,000 × were projected on to a piece of paper. At each investigation about a hundred cells were drawn or measured, and the mean diameter and the mean volume were computed. Greatly deformed cells were avoided: otherwise all of them have been measured. It was found that one of the young (*C*) in the litter had quite normal blood-cells and that it was thus presumably a diploid. Two of the young, a male (*B*) and a female (*A*) showed a cellular volume of about 1·5 times the value found for normal rabbits. We have therefore considered it warrantable to presume that both these animals are triploids. They show, in fact, very rapid growth. A normal rabbit is not fully grown until about the age of one year. The triploid female, which grows more rapidly than the male, passed the mother's weight at the age of three and a half months and the father's at rather more than five months. Their growth-curves are reproduced herewith.



Growth curves of the three rabbits

The triploid male became sexually mature at the age of about five months. It shows normal sexual instincts. The sperm-head, as is well known, consists of nucleus only, and it does not show any functional changes in volume. Disturbances in spermatogenesis, however, may entail some variation in the size of the sperm-heads (Savage, Williams and Fowler, Moench, Lagerlöf). No such variation or sign of disturbances in spermatogenesis has been found in our animal material. Measurement of the volume of these nuclei—about a hundred have been measured—as compared with those of a normal animal gives the ratio of 1·45 : 1·00. We have continued this rabbit series, but it has not as yet been developed. As similar tests may perhaps assume import-

ance for the breeding of domestic animals, we have started tests on larger domestic animals.

A detailed report of this work will be given elsewhere.

[1] Belling, J., *J. Hered.*, **16**, 461 (1925).
[2] Randolph, L. F., *Proc. U.S. Nat. Acad. Sci.*, **18**, 222 (1932).
[3] Blakeslee, A. F., *C.R. Acad. Sci., Paris*, **205**, 476 (1937); *Gard. Chron.*, **103**, 270 (1938).
[4] Gross, F., *Naturwiss.*, **29**, 962 (1932).
[5] Rostand, J., *C.R. Soc. Biol., Paris*, **113**, 346 (1933).
[6] Griffiths, R. B., *Genetica*, **26**, 69 (1941).
[7] Fankhauser, G., *Proc. Amer. Phil. Soc.*, **79**, 715 (1938); *Biol. Symposia*, **6**, 21 (1942); *Quart. Rev. Biol.*, **20**, 20 (1945).
[8] Häggqvist, G., *Proc. Koninkl. Nederland. Akad. Wetensch.*, **21** (1948).
[9] Pincus, G., and Waddington, C. H., *J. Hered.*, **30**, 515 (1939).
[10] Beatty, R. A., and Fischberg, M., *Nature*, **163**, 807 (1949).

DESIGN AND EVALUATION OF BIOLOGICAL ASSAYS

A QUARTER of a century ago a cumbrous and uncertain tool, to-day a versatile instrument of known precision, biological assay has during its evolution stimulated new biometrical thought as much as pharmacological research; and it would be difficult to say whether this developing use of living organisms in the estimation of biological potency and in quantitative biochemical analysis owes more to practical suggestions from statisticians or to improved statistical devices contributed by biologists not primarily concerned with statistics. Both professions being still in constant need of each other's brains in this field, the Biometric Society (British Region) and the Biological Methods Group of the Society of Public Analysts and Other Analytical Chemists organised a joint meeting in London on March 14, partly to read and discuss papers, and partly as an open forum for questions of mutual interest.

The afternoon session enjoyed the chairmanship of a pioneer of bioassay, Dr. J. W. Trevan, of the Biometric Society. The opening paper, by Mr. N. T. Gridgeman, on "The Graphical Calculation of the Errors of Biological Assays with Graded Responses", described the reduction of the complex expression for the fiducial limits of error, at a given probability level, to

$$I\left[R\,(C-1) \pm \sqrt{(C-1)\,(R^2C+1)}\right],$$

where I is the log dose-interval, R is the response difference (test material minus standard) as a fraction of the dose-interval response difference, and C is Fieller's correction factor. The percentage limits of error are given by 100 times the antilogarithms of this expression, which, incidentally, is applicable only to symmetrical or near-symmetrical assays. The symbol C being a simple function of assay size and response sensitivity, it is possible to construct a nomogram from which C can be read off from n, the total number of animals in the assay, and the statistic λ, the residual standard deviation in terms of the slope of the response/log-dose curve. For a given value of I, a series of error curves can be drawn with C and R as co-ordinates. The chart exhibited, combining the nomogram and the error curves, enables the fiducial limits of a four-point assay to be read off for wide ranges of n, λ and R. A similar chart exists for six-point assays. In presenting the charts, Mr. Gridgeman stressed three advantages in their use: saving of time; reduction of computing mistakes; and easy detection of the factors responsible for unusually narrow or wide limits.

Dr. E. C. Wood then read his paper on "The Estimation of Error in Certain Types of Biological Assays". He began by remarking that it is seldom convenient or economic so to design a graded-response assay that a true estimation of residual error is calculable. A common design employs litters of the same number of animals as there are dosage groups; this necessitates the use of the interaction term, treatments × litters, as the error variance, the true residual term, obtainable only from intra-litter replication of dosages, being inaccessible. However, the occasional availability of big litters permits a doubling-up of treatments within them, and estimation of the true residual variance becomes possible. A collection of relevant data from Dr. Wood's own, and from Mr. A. L. Bacharach's, experimental records had been analysed, and in many instances it was found that the treatments times litters interaction (on which the limits of error of the assay would normally be based) was significantly greater than the residual error. In other instances the total interaction did not bulk large, but one or more of its orthogonal components (for example, slope × litters, parallelism × litters) emerged significantly greater than the residual error. From these observations Dr. Wood concluded that not only is the true residual variance, being sometimes smaller than the interaction term(s), not worth seeking, but also that intra-litter replication is pointless—'extra' animals in litters might as well be discarded, for all the information they can yield.

Correct pooling of the results of non-adjacent and perhaps variously designed assays presents subtle difficulties, some of which were dealt with by Mr. E. C. Fieller in his paper, "The Problem of Combining the Results of Independent Assays". He illustrated one form of the problem with an example from the literature. This comprised three assays of the same material, against the same standard, spaced over a thirteen-month period; all were asymmetric, each was of different size and only one fulfilled on its own account the requirements of biometric validity. Analysis of variance showed, however, that all the embodied estimates of slope, and of residual variance, were statistically homogeneous. Appropriate weighting of the log-doses and of the response differences for each assay yielded valid pooled estimates of the slope and, separately, of the standard minus test-material difference, from which the best estimate of the pooled assay and its limits of error readily follow. It is notable that the worst of the three assays, which, evaluated by itself, yielded limits of error, at the five per cent probability level, from zero to infinity, could yet contribute materially to the pooled assay and help confine its error.

Turning to assays with disparate slopes, Mr. Fieller showed that, in general, the same procedure can apply, for it does not hinge on an assumption of slope homogeneity. If we call the slope B and the standard minus test-material difference Y, the values $B_1, B_2 \ldots B_n$ may differ, but so, proportionally, will the values $Y_1, Y_2 \ldots Y_n$, so that the appropriately weighted $\overline{B}$ and $\overline{Y}$ can be used, just as if $B_1, B_2 \ldots B_n$ were samples of the same population, to obtain an unbiased estimate of the logarithm of the required activity-ratio. Disparity of slope would, of course, be properly reflected in the magnitude of the error of the final estimate.

The evening session of the symposium, with Mr. N. T. Gridgeman, of the Biological Methods Group, in the chair, opened with a discussion of the papers

epitomized above. Mr. D. J. Finney, commenting on the symbolizing by Mr. Gridgeman of the response-difference ratio by R, a letter used elsewhere for the activity ratio, went on to deplore the lack of uniformity in the notation of bioassay statistics generally. The chairman, echoing Mr. Finney's criticisms, expressed the hope that the question of symbol standardization would be settled at an international level, an imperfect but universally accepted notation being better than a perfect one in limited use. Dr. J. I. M. Jones thought that fundamental statistical symbols need standardization, but doubted the practicability of inclusion of derivatory symbols, some of which are short-lived in a world of changing formulæ; the important thing is to collect and define all non-standard symbols in every communication.

Numerous speakers, including Messrs. Fieller, Healy, Bacharach, Finney and Broom, discussed Dr. Wood's paper, the gist of their conclusions being that replications of treatments within litters is understandably of small value; as Mr. M. J. R. Healy put it, the underlying population is litters, and it is desirable to sample this population as widely as possible. Mr. Finney drew an analogy with replicated estimates of a variate n times on m individuals versus single estimates on nm individuals, the latter being far more informative. Dr. Wood concurred, and added as an extension that an assay embracing litters from different laboratories is more valuable than an assay of equal size on litters from a single laboratory.

Concerning Mr. Fieller's paper, Dr. Jones commented on the value of the treatment of the data of the three particular assays in dispelling the superficial inference that the test material had lost potency during the period covered by the assays; the statistical treatment showed that chance would so distribute the results too often to allow weight to be given to apparent time trends. Mr. P. Armitage asked whether the author had compared his method with the common approximate method of weighting the log activity-ratio of each constituent assay with the reciprocal of the variance of that estimate—a method independent of inter-assay differences in variance and slope. Mr. Fieller stated that, in the example given, the weights to be attached to the ill-designed constituent assays were too inaccurate to make the older method usable.

The last part of the meeting was devoted to open discussion of some problems of design and interpretation raised, by previous invitation, by members of the Societies. The problems fell into certain well-defined categories. For example, response curves of unusual position and shape produced questions. Discussion of non-parallel response curves led to the asseveration that the standard and the material under test must not only, in that event, be chemically dissimilar but also must behave differently in the soma; therefore, except in certain special pharmacological cases wherein relative activity is recognized to be a function of dosage-level, the assay must be held invalid. In microbiological assays the occasional peculiarly shaped curve raised difficulties that were argued by Mr. S. A. Price, Mr. J. S. Harrison, and others. It was held to be a biological rather than a statistical problem. So long as the standard and test-material curves are comparable in shape, statistical devices can extract valid assays. The curves can, indeed, as Dr. A. F. Parker-Rhodes mentioned, be mathematically straightened, and Dr. Wood directed attention to his 'doping' technique to linearize the lower parts of response curves.

Designs for assays in which the number of dosage groups exceeds the number of animals per litter were discussed. Mr. Bacharach suggested complete randomization. Mr. Finney thought that partial confounding of interactions as developed in agricultural work provides the best solution. In this connexion Mr. J. V. Smart warned against inadvertent confounding of important interactions, and thought that pilot experiments to assess interactions might be advisable.

Questions were tabled on the influence of uncontrollable variants on responses—for example, the effect of insulin on blood sugar and that of vitamin P on capillary resistance depend on the initial status of the organism. Again, some toxicologists, assuming a relation between body weight and response, dose proportionately instead of so much per animal. The underlying problem is: How are these effects best handled? Messrs. Finney, Wood, Gridgeman and others agreed in advocating initial measurement of the variant, followed by, in all cases (including, within wide limits, toxicity tests), equal doses per animal, and, finally, adjustment where necessary of the responses by covariance analysis to allow for the influence of the uncontrollable variant.

From two sources came queries on the principles governing the selection of animals for test (for example, animals insensitive to rachitogenesis are avoided in vitamin-D assays) and the rejection of data after test (for example, some assayists include a weight loss in growth tests, and others erase the record of that animal, or of its whole litter). A wide-ranging discussion, led by Mr. Bacharach, Dr. Jones, Mr. P. R. Booth, Mr. Finney and Mr. Gridgeman, moved towards the following tentative conclusions: (1) that pre-selection of test animals is justifiable and profitable if the assay is of the purely analytical type, but harbours dangers in potency comparisons of different materials; (2) that, in the absence of observational evidence, no valid criterion exists for the rejection of odd discrepant responses; and (3) that a firm ruling cannot be made on the treatment of weight losses in growth assays, but that their inclusion among results that also contain deaths during the test period involves a logical paradox. As an eminent statistician has declared, some of the points here at issue are moral rather than statistical.

A request for statistical advice on the arrangement of trials involving stepwise dilution initiated a discussion on what was clearly incompletely surveyed territory. Exemplifying the problem, Dr. H. O. J. Collier and Mr. I. F. Hall described tests to compare the efficacy of divers ingested sulphonamides as fæcal bactericides. Pooled fæces from groups of mice so treated were suspended in peptone water and serially diluted in two-times steps. The tubes were autoclaved and infected, and the degrees of bacterial growth after different periods of incubation were recorded, in one experiment, as (−), (− +), (+) and (+ +). In a second experiment, in which the fæces from the individual mice of a group were treated separately, the metameter was the proportion of tubes per group showing growth. Having established that a continuous variate could not be introduced (turbidimetry, for example, would be queered by fæcal particles), the relative merits of the two experimental designs were debated, and it was agreed that the second was the better. Mr. Healy suggested the use of probits, as in toxicity trials, and Mr. Finney spoke on the application of a scoring system to give values amenable to standard statistical treatment.

N. T. GRIDGEMAN

BRITISH MATHEMATICAL COLLOQUIUM AT OXFORD

THE second British Mathematical Colloquium was held at Oxford during April 12–14. More than a hundred and twenty mathematicians assembled from all parts of the British Isles, and the meeting also attracted a sprinkling of foreign visitors from Egypt, Holland, India and Italy. The members were comfortably accommodated at Jesus College, and the main lectures were held in the Physical Chemistry Lecture Theatre.

This gathering of ('pure') mathematicians will now become an annual event. The first Colloquium was held at Manchester last September, and the next one will take place at Bristol in September 1951. For the present year, April was chosen to avoid a clash with the first post-war International Congress of Mathematicians which is due to meet in Cambridge, Massachusetts, during the first week in September.

The aim of the British Mathematical Colloquium is twofold: in co-ordinated lectures of one hour's duration surveys are given of the progress in some important field of research which are meant to be—and indeed succeed in being—intelligible to the non-specialist and enable him to keep himself informed of major developments; and in the more intimate atmosphere of 'study-groups', mathematicians with common interests in special branches of their science report on their results and raise and discuss problems for further research. While the former meetings are more instructive, the latter tend to be more stimulating.

One of the surprises of the Oxford meeting was the awakening interest in modern algebra among mathematicians in Great Britain. There have been many eminent British algebraists during the past hundred years—it is sufficient to mention the names of Hamilton, Cayley, Sylvester, Burnside and Young; but they founded no schools, and algebra was allowed to lapse almost into oblivion. The startling developments which originated in Germany during the twenties and rapidly spread to other countries, notably the United States and the U.S.S.R., were too long ignored in Britain. All this is changed now: at Oxford algebra stood in the forefront of interest. Among the most successful lectures there were those which dealt with: the impact of modern algebraic concepts and methods on analysis; the algebraic theory of valuation and its many applications, which range from the theory of ideals in rings to the foundations of algebraic geometry; the interaction of algebra and topology in the theory of topological groups; and the way in which topology begins to repay for the services rendered to it by algebra. This was exemplified in the concept of co-homology, which arose in topology but is capable of an algebraic interpretation and treatment. Moreover, the liveliest of the discussion groups was that on algebra. There were other groups: on the theory of numbers, on algebraic geometry, on random functions and on non-linear differential equations. But the algebraists were insatiable; long after the Colloquium had ended 'officially' and the other groups had concluded their proceedings, the algebraists still went on proving, discussing and conjecturing.

An important feature of the Oxford meeting was a lecture by Prof. B. Segre, of the University of Bologna, who was enabled by the co-operation of the British Council to prolong his visit to Great Britain. In a brilliant performance, worthy of the tradition of the great Italian school of geometry, he demonstrated the solution of a problem which was proposed to him only a fortnight before by Prof. J. G. Semple, of King's College, London, namely, to characterize the inflexional curve of an algebraic surface in four dimensions.

K. A. HIRSCH

ANTIBODIES IN FOOT-AND-MOUTH DISEASE

THE Report Series issued by the Agricultural Research Council already includes eight useful publications on a variety of subjects. No. 9 of this series, written by Dr. J. R. Brooksby and entitled "The Antibodies in Foot-and-Mouth Disease"*, reports work carried out under the Foot-and-Mouth Disease Research Committee of the Agricultural Research Council as part of a programme of work designed to develop reliable standard methods for the study of this disease.

Part 1 discusses the detection and measurement of antibodies to the virus of foot-and-mouth disease. The methods used for the estimation of antibodies are reviewed, and the best conditions for the conduct of the guinea-pig protection test are described. This test has, however, a limited value. The best method of assay of antibody titre is the bovine neutralization test, and examples are given of the use of this test for the detection of antibody in sera of vaccinated cattle. The result of the neutralization test in one large experiment has been correlated with the determination of the protective power of convalescent serum against contact infection in cattle and against the inoculation of virus on the tongue. The typical convalescent serum used gave a fair measure of protection at a dose of 50 ml. per cwt. under conditions of exposure to infection which were more severe than those usually encountered in the field. A dose of 150 ml. per cwt. gave complete protection. Attempts to use the complement-fixation test for the measurement of antibody showed that this test is not successful for this purpose with bovine sera or concentrated antibody solutions.

Part 2 of the report discusses the distribution of the antibody in the serum fractions and also the preparation of concentrated antibody solutions. The association of the antibody with the euglobulin fraction obtained by ammonium sulphate precipitation has been demonstrated, but the partition of antibody between euglobulin and pseudoglobulin varies very much in different sera, especially before the fourteenth day of convalescence. There appeared to be a similar variation in the distribution of antibody in fractions obtained by electrophoresis.

Direct evidence of the activity of other fractions has not yet been obtained. A simple method used for the preparation of concentrated antibody solutions has produced solutions six to eight times more potent than convalescent serum. Doses of 19 ml. per cwt. of one of these preparations had a protective value equal to that of 150 ml. per cwt. of the original serum. Dr. Brooksby quotes experimental results which show that alcohol precipitation helps the demonstration of antibody in sera in which its concentration is low.

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* The Antibodies in Foot-and-Mouth Disease. Agricultural Research Council. Report Series, No. 9. By Dr. J. B. Brooksby. Pp. vii+87. (London: H.M. Stationery Office, 1949.) 3s. 6d. net.

LETTERS TO THE EDITORS

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Elimination of Losses in the Quantitative Estimation of Amino-Acid by Paper Chromatography

SEVERAL methods[1–6] have been published for the quantitative estimation of amino-acids after separation by filter-paper chromatography. In general, these methods have only been applied to simple amino-acid mixtures, which can be resolved on a one-dimensional chromatogram. In investigating the possibility of quantitative estimation of amino-acids in complex mixtures, we have examined the accuracy of most of these methods. The most sensitive and accurate method in our hands is a colorimetric ninhydrin method based on that of Moore and Stein[7]. Applying the method directly to pieces of filter paper, there is a high and variable 'amino-acid' value, due mainly to the presence of absorbed ammonia. The colour response per mole of ammonia is about the same as that of an amino-acid. By treatment of the paper with dilute alkali immediately before the determination, the absorbed ammonia is removed, the 'paper blank' becomes very low and constant, and the colour response from a standard amount of an amino-acid added to small squares of filter paper is identical with that produced from the same amount of amino-acid in the absence of paper, provided the appropriate paper blank correction is applied.

When a mixture of eight amino-acids in amounts corresponding to 8 μgm. α-amino-nitrogen of each amino-acid was chromatographed overnight at 23° C. on Whatman No. 4 filter paper strips using phenol–ammonia as solvent, the recoveries were 75–80 per cent. The colour produced from standard amounts of the amino-acids added to similar-sized blank pieces of paper taken from the dried chromatogram was used as control. The colour response of these controls was the same as that given by the amino-acid when added to the untreated paper. Using an *n*-butanol acetic acid mixture[8] as solvent, the recoveries were approximately 90 per cent. In these experiments the solvents were removed by drying in a hot-air oven at 90–100° C.; and the amino-acid spots could then be located by fluorescence in ultra-violet light.

The effect of initial concentration and of the distance flowed on the recovery of a typical amino-acid, alanine, was studied using phenol–ammonia and the *n*-butanol acetic acid mixture as solvents. The results given in Tables 1 and 2 show that the amount recovered is independent of both the initial concentration of the alanine and the distance the amino-acid has flowed. These facts suggest that the loss which occurred is not due to 'trailing' of the amino-acid on the paper. Woiwod[9] has obtained different results using glycine (an atypical amino-acid) estimated by the copper-complex method.

The effect of the drying process on the recovery of standard amounts of alanine (8 μgm. α-amino-nitrogen in 50 μl.) was then investigated. The solution of the amino-acid was spotted on to equal-sized pieces of Whatman No. 4 paper and allowed to dry. The areas containing the amino-acid were wetted with water-saturated phenol, and the papers dried at 75° C. or 100° C. for three hours. These temperatures are the extremes of the range which is generally employed for this type of work. The recoveries after these heat treatments were 86 and 74 per cent respectively. No loss was observed in the absence of solvent; the amino-acids always exhibited strong fluorescence in ultra-violet light after heating at these temperatures.

In another experiment, standard amounts of alanine were applied as separate spots to a large sheet of Whatman No. 4 paper and chromatographed in the usual manner for 20 hr. using phenol–ammonia as solvent. The wet paper was then removed from the chromatography tank, and equivalent amounts of the amino-acid were spotted on to blank areas of this paper. The sheet was then dried at 75° C. Recoveries of alanine which had been chromatographed and of the amino-acid added to the wet paper just before drying were both 86 per cent of the theoretical. When this experiment was repeated using a drying temperature of 100° C., the recoveries were 75 per cent in each case. These experiments indicate that by drying at high temperatures some of the amino-acid is destroyed, probably due to oxidation, but that in the running of alanine there is no appreciable loss. While this work was in progress, Berry and Cain[10] published qualitative results suggesting some destruction of amino-acids during the drying of chromatograms at high temperatures.

An attempt was then made to recover the theoretical amount of alanine from the chromatograms by eliminating the hot-drying process. A series of separate alanine spots were run on the same sheet of paper using phenol–ammonia as solvent. While still wet, the paper was cut into strips along the direction of solvent flow. Some of these strips were dried by the usual heat treatment at 100° C., the remainder being washed thoroughly with ether to remove the solvent and allowed to dry in the air. A number of the ether-washed strips were heated at 100° C. for 30 min. The positions of the amino-acid on the heated strips were found by their fluorescence in ultra-violet light, and these were then used to locate the positions of the amino-acid on the unheated strip. Whereas the recovery of the amino-acid was again 75 per cent of the theoretical after the standard hot-drying procedures, it was increased to 98 per cent when the solvent was removed before drying. As was to be expected from the previous results, no loss occurred on heating after the removal of solvent. Similar experiments using phenylalanine and glutamic acid

Table 1

Alanine (μgm.)	Recovery (%) *n*-butanol acetic acid	Recovery (%) phenol–ammonia
10	78	78
20	92	78
40	91	82
50	90	86
60	92	78
70	92	87

Table 2

Distance of amino-acid flow (cm.)	Recovery (%) *n*-butanol acetic acid	Recovery (%) phenol–ammonia
3	95	—
6	95	75
10	95	81
16	95	77
22	91	—
28	94	77

have also shown recoveries of 97–101 per cent after the ether-washing treatment. We have evidence which indicates that, provided drying is carried out at temperatures not exceeding 50° C., losses with alanine are also negligible.

Since two-dimensional chromatography involves two drying stages, it would be expected that the losses observed would be correspondingly greater than in one-dimensional separations if the paper is dried at elevated temperatures. The recoveries of the amino-acids used by us in two-dimensional chromatograms have generally been of the order of 70 per cent when run in phenol–ammonia followed by *n*-butanol acetic acid as solvents. The loss found using phenylalanine was usually greater, the recovery never exceeding 60 per cent. Preliminary experiments with both alanine and phenylalanine on two-dimensional chromatograms using the above solvents indicate that losses not greater than 8 per cent result, provided the hot-air drying is eliminated.

A full description of the ninhydrin method employed and its application to the quantitative estimation of amino-acids in paper chromatography will be published elsewhere.

We wish to express our thanks to Prof. B. S. Platt for his interest in this work.

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Degradation of Deoxyribonucleic Acid by Free Radicals

In an earlier communication[1], discussing the analogy between the action of X-rays and of radiomimetic chemicals on thymonucleic acid, we commented on the nature of the changes which occur after the irradiation with X-rays has stopped. We pointed out that these changes might be due to the radicals produced by the irradiation, which themselves have a very short life, either initiating a chain reaction which results in the degradation of the nucleic acid, or forming intermediate products such as hydrogen peroxide or other peroxides which continue the action. In order to distinguish these possibilities, it was clearly desirable to determine the effect on the thymonucleic acid of hydroxyl radicals produced by alternative methods.

As is well known, hydrogen peroxide is easily decomposed by ultra-violet light of wave-lengths less than 3700 A., yielding hydroxyl radicals[2]. It has been found that deoxyribonucleic acid in solutions containing 0·002 *M* hydrogen peroxide is degraded by quite short exposures to ultra-violet light from a

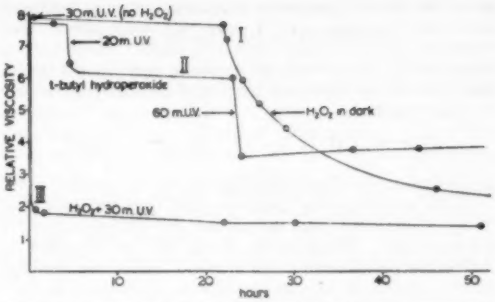

Fig. 1. Irradiation of the thymonucleic acid in presence of hydrogen peroxide or *tert.*-butyl hydroperoxide

mercury arc (Fig. 1). This treatment has very little effect on the nucleic acid without hydrogen peroxide. Hollaender, Greenstein and Jenrette[3] found that deoxynucleic acid in aqueous solution is slowly degraded by ultra-violet radiation; but the rate of the change is very much less than in the presence of very small concentrations of hydrogen peroxide. In one of their experiments, irradiation for 83 hr. was required to degrade the nucleic acid.

Hydroxyl radicals are also produced in the dark reaction between hydrogen peroxide and ferrous ions:

$$H_2O_2 + Fe^{++} = HO + Fe^{+++}(OH^-),$$

which has been investigated by Haber and Weiss[4], and by Baxendale, Evans and Park[5]. This mixture was found to be very effective in degrading the thymonucleic acid (Fig. 2). In these reactions the change of viscosity occurs rapidly and mainly during the actual liberation of hydroxyl radicals. The after-effect, so far as it has been observed, is comparatively small. There is no indication in these cases that the OH radical initiates a chain reaction which continues when the formation of the radicals has ceased. The small after-effects which do occur can be ascribed to residual hydrogen peroxide.

It has been established[6] that bacteria grown on a substrate recently exposed to ultra-violet light are subject to high mutation-rates. Dickey, Cleland and Lotz[7] have suggested that this is due to the formation of organic peroxides under the irradiation. They have shown that a number of peroxides and especially *tert.*-butyl hydroperoxide have a strong mutagenic effect on *Neurospora crassa*. In view of this, we examined the action of this substance (kindly given to

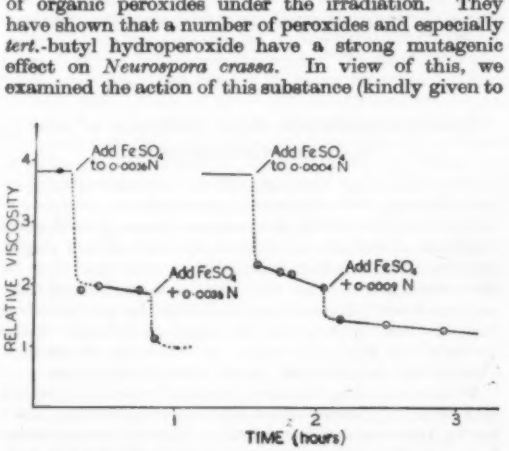

Fig. 2. Action of a mixture of hydrogen peroxide and ferrous sulphate on thymonucleic acid

us by Dr. W. C. J. Ross) on the nucleic acid in buffered solutions between *p*H 7 and 9. No effect was observed over at least fourteen days. However, a short illumination with ultra-violet light (see Fig. 1), which no doubt liberated hydroxyl radicals, according to the equation

$$C_5H_9O\text{—}OH + h\nu = C_5H_9O^{\bullet} + OH^{\bullet},$$

caused an immediate degradation of the nucleic acid.

These experiments indicate that free radicals produced chemically can cause the depolymerization of nucleic acid. Much more work will be required to define the conditions more closely. The close analogy of the action of the radiomimetic chemicals in promoting depolymerization discussed in the previous note[1] suggests at least the possibility of similar mechanisms. Free-radical mechanisms must also be considered to account for the mitotic abnormalities, mutations, etc., which these chemicals produce.

Note added in proof, May 11. Since writing the above, we have noticed that the chemical degradation of thymonucleic acid by the Fe – H_2O_2 mixture has previously been observed by Dr. J. Weiss, G. Scholes and G. Stein[8], who isolated urea from the product.

We have also found, in experiments performed in conjunction with Dr. B. E. Conway, that in solutions carefully freed from oxygen, no appreciable change of viscosity occurs *after* the completion of the irradiation by X-rays. This shows that the 'after-effect' mentioned above is due to a reaction product of oxygen with a primary product of the irradiation, presumably hydrogen peroxide. A detailed account of this experiment will be published elsewhere.

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Desoxyribonucleic Acid Content of the Ciliate Micronucleus

Most existing accounts of the mitotic cycle in animals seem to indicate that the synthesis of desoxyribonucleic acid of the chromosome takes place during prophase of mitosis, so that at the end of this stage, the desoxyribonucleic acid content is double that of the interphase nucleus and this becomes halved during anaphase[1]. Support for this view by photometric analysis has been given by Caspersson[2] and more recently by Ris[3], who find an increase of desoxyribonucleic acid taking place during prophase.

While examining Feulgen preparations of the normal and dividing micronuclei of *Chilodonella uncinatus* Ehrbg. (Protozoa: Ciliata) it was noticed that conditions here were at variance with those usually reported in metazoan nuclei. Photometric measurements (see Pollister and Moses[4] for details of apparatus) revealed that daughter micronuclei soon after separation showed values about half those of the normal interphase nuclei. The mean of twenty such measurements is given below:

Desoxyribonucleic Acid Determination of Micronuclei of *Chilodonella uncinatus*. Extinction at 557 mμ of Feulgen Reaction of Whole Nuclei

	Interphase nuclei	Nuclei soon after mitosis
Diameter (μ)	1·7	1·7
Volume (μ^3)	2·57	2·57
Extinction (E)	0·332 ± 0·015	0·152 ± 0·010
Relative amount (Er^3)	0·753	0·345
Relative concentration ($E/\frac{4}{3}r$)	0·293	0·134

These figures indicate that the micronucleus soon after division has about half the desoxyribonucleic acid content and should therefore build up the normal quantity during interphase. This is at variance with the findings of earlier workers on metazoan nuclei, who saw in prophase of mitosis a doubling of the desoxyribonucleic acid content. Swift[5], working in the Columbia University Zoology Laboratories, recently made some measurements of dividing nuclei of *Ambystoma* (pronephros, erythrocytes), mouse embryos (liver) and corn (root meristem) and finds in these tissues also that telophase nuclei have only half the desoxyribonucleic acid content of interphase nuclei, and believes that synthesis of desoxyribonucleic acid must take place during interphase.

This work was done in the Zoology Laboratories of Columbia University, New York, during 1949.

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Use of the Arsenomolybdate-Somogyi Reagent in Quantitative Paper Chromatography, and its Application to the Study of Sucrose Utilization by a Fungus

We have studied a strain of *Chætomium globosum* which was cultured on the basal medium of Buston and Basu[1] ($NaNO_3$, 2 gm.; KH_2PO_4, 1 gm.; KCl, 0·5 gm.; $MgSO_4.7H_2O$, 0·5 gm.; $FeSO_4$, 0·01 gm., in 1,000 ml. water) with the addition of 5 per cent sucrose and 2 per cent yeast extract. 50-ml. portions contained in 500-ml. flasks were inoculated with 1 ml. of a spore suspension and incubated at 25°. Samples were withdrawn aseptically from the culture flasks at intervals and spotted on a paper chromatogram[2] and developed with *n*-butanol – water for 56 hr.

Sugars were identified and extracted from the paper[3,4] and estimated in the solution and in standards by the method of Nelson[5], using the Somogyi copper reagent buffered with sodium carbonate and bicarbonate, but containing no potassium iodide or iodate, which interfere with the production of a colour with the arsenomolybdate reagent. The optical density of the solution was measured on a spectrophotometer

at 500 mμ set to read zero density through a water/paper blank. In a typical estimation an accurately measured volume (0·015 ml.) of culture medium was spotted on a chromatogram (Whatman No. 1 filter paper). After developing in the usual way, the sugars were extracted from the appropriate strips of paper with water (5 ml.) contained in the usual 200 mm. × 25 mm. test-tube, with ground-glass joint, in which the solution was retained throughout the analysis. The copper reagent (1 ml.) was added and the tubes heated at 100° in a water bath for 20 min. After cooling, the arsenomolybdate reagent (1 ml.) was added, followed by water (18 ml.) from a burette to bring the total volume to 25 ml. The error due to varying amounts of water being retained by the spiral of the extractor condenser is small.

In the case of sucrose, the solution (5 ml.) and a standard solution were hydrolysed by heating for 60 min. at 100° with 5 per cent oxalic acid solution (1 ml.). It was necessary to use 5 ml. of the copper reagent to avoid any marked change in *p*H due to the acid present. After development of the colour in the usual way, water (9 ml.) was added to bring the total volume to 25 ml., and the optical density measured as indicated.

The method is considered to be as accurate as the titrimetric procedure[4] and is better adapted to routine determinations. The range covered is approximately 10–350 μgm. sugar.

The results of analysis are presented in the accompanying table.

Concentrations of Sucrose, Glucose and Fructose (%)

Days of Incubation	Sucrose		Glucose		Fructose	
	1	2	1	2	1	2
0	4·93	4·97	—	—	—	—
3	4·35	3·90	0·24	0·19	0·53	0·49
6	3·10	3·80	0·90	0·63	1·19	0·73
9	1·80	1·84	1·02	0·98	1·95	1·30

1 and 2 represent duplicate flasks. Determinations in duplicate were carried out in each case.

It will be seen that the disappearance of sucrose from the medium is accompanied by the production of increasing amounts of glucose and fructose. The fact that fructose appears in quantities up to some 50 per cent greater than those for glucose is of considerable interest (cf. ref. 6).

Further work on the carbohydrate metabolism of micro-organisms, using this convenient technique, is now in progress at this Institute.

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Repair *in vivo* of the Surface Structure of the Guinea Pig Erythrocyte

Erythrocytes treated intensively with a bacterial enzyme present in culture filtrates of *V. choleræ* are no longer agglutinable by viruses of the mumps–influenza group. During treatment with this 'receptor-destroying enzyme' of *V. choleræ*, agglutinability for the various strains is lost in a definite sequence which closely parallels the order obtained when the viruses are arranged according to the extent of their own enzymic action on the cells. This phenomenon has been termed the 'receptor gradient'[1].

Table 1

Units of RDE per 0·25 ml. packed cells 30 min. at 37° C.	Electrophoretic mobility* μ/sec./volt/cm.	Agglutination by standard dose of MEL (*A*)	PR8 (*A*)	NDV	WSE (*A*)	SWINE (*A*)	LEE (*B*)	BEL (*A*)	MIL (*B*)
Nil	1·11	++	++	++	++	++	++	++	++
94	0·80	++	++	++	++	++	++	++	++
188	0·64	+	++	++	++	++	++	++	++
375	0·52	−	−	+	++	++	++	++	++
750	0·41	−	−	−	−	+	++	++	++
1,500	0·38	−	−	−	−	−	−	+	++
3,000	0·31	−	−	−	−	−	−	−	++
6,000	0·24	−	−	−	−	−	−	−	−

(*A*), (*B*), influenza virus, type *A* and *B*.
++ = complete agglutination of guinea pig cells; + = partial agglutination of guinea pig cells; − = no agglutination of guinea pig cells; NDV = Newcastle disease virus.
* Determined in *M*/15 sodium potassium phosphate buffer *p*H 7·35.

Recently, Ada and Stone[2] found that the progressive loss of agglutinability of human erythrocytes when treated with viruses or receptor-destroying enzyme was closely paralleled by a reduction in their electrophoretic mobility. We have found that guinea pig cells behave in essentially the same fashion. If aliquots of such cells are incubated at 37° C. with doubling dilutions of receptor-destroying enzyme for a standard time and the reaction stopped with anti-receptor-destroying enzyme serum, a receptor gradient[1] can be obtained, as is demonstrated in Table 1.

The recent availability of highly purified receptor-destroying enzyme[3] has enabled an *in vivo* study to be made of the action of this reagent. A preliminary experiment showed that guinea pigs tolerated the enzyme well. They were given 50,000 units of receptor-destroying enzyme in 1 ml. of saline intracardially. Twenty-four hours later, the electrophoretic mobility of the circulating erythrocytes had fallen from 1·11 to 0·33 μ/sec./volt/cm., the receptors for all the viruses other than MIL being removed. After seventy-two hours, a few cells of somewhat faster mobility were noticed and, on the fourth or fifth day following injection, cells of normal mobility appeared. Afterwards, the ratio of normal mobility (fast) to slow cells increased until, on the tenth day, there were approximately equal numbers of fast and slow cells with great variation in individual guinea pigs. A proportion of cells, roughly estimated at about 10 per cent, was of intermediate values. By the twentieth day, however, all cells were of normal mobility; those with intermediate values were the last to disappear. Simultaneously with the reappearance of normally mobile cells, there was evidence of increasing agglutinability of the cells by the various viruses.

Following injection of receptor-destroying enzyme, the titre of the serum inhibitor for heated influenza virus LEE[4] fell sharply and remained at a low level for forty-eight hours. Thereafter, the value steadily

rose, returning to the original level in sixteen to twenty days.

Transfusion of guinea pigs with cells treated with receptor-destroying enzyme in amounts equivalent to 6 ml. of whole blood was also carried out. In a typical experiment a sample of the recipient guinea pig's cells taken half an hour after the transfusion contained 13 per cent slow cells. Twenty-four hours later this value had dropped to 8 per cent and within seventy-two hours all cells were of normal mobility.

There appeared to be three possible explanations for the rapid disappearance of the slow cells in all these experiments, namely: (1) erythrocytes treated with receptor-destroying enzyme are removed at an abnormally fast rate and replaced at a similar rate by newly formed cells; (2) normal guinea pig cells have an average life-span of less than twenty days; or (3) there is no gross destruction of cells treated with receptor-destroying enzyme, the virus receptors being regenerated while the cells remain in circulation.

If the first hypothesis were correct, then signs of excessive blood destruction should be evident. In our experiments, no reticulocyte response or increase in the urobilinogen content of the urine and no significant change in the hæmoglobin value of the guinea pigs were detected. On the other hand, the sensitivity of guinea pigs to blood loss is such that withdrawal of 5 ml. of blood results in a reticulocyte count of 7 per cent in six days (normal count 0·1–0·5 per cent). While we have been unable to find any reference in the literature to the life-span of the guinea pig erythrocyte, values for rat, rabbit, dog and human cells vary from 65 days in the case of the rabbit[5] to 127 days for humans[6]. It would seem most unlikely that guinea pig erythrocytes have an average life-span of less than twenty days. Consequently, we favour the surface regeneration hypothesis. Further evidence supports this view. Following the injection of receptor-destroying enzyme into guinea pigs, anti-receptor-destroying enzyme serum[7] was given twenty-four hours later to neutralize any remaining enzyme. The agglutination reactions of cells taken from the guinea pigs at various times after the administration of receptor-destroying enzyme are presented in Table 2. It is apparent that the agglutinability of the erythrocytes with the various viruses returns in an order which is the mirror image of that obtained by the action of receptor-destroying enzyme.

Table 2

Number of days after RDE injection	Percentage of fast cells	Agglutination by standard dose of MEL (A)	PR8 (A)	NDV	WSE (A)	SWINE (A)	LEE (B)	BEL (A)	MIL (B)
2	0	−	−	−	−	−	−	−	++
4	4	±	±	±	+	+	+	++	++
6	20	+	+	+	++	++	++	++	++
>20	100	++	++	++	++	++	++	++	++

If simple replacement of treated cells by normal cells was occurring, one would expect a uniform degree of agglutination with each of the viruses. Such a result is obtained when viruses are added to artificial mixtures composed of varying proportions of normal cells and cells treated with receptor-destroying enzyme.

Repair of the erythrocyte surface *in vivo* implies that some constituents of the mammalian red-cell membrane may undergo rapid metabolism. Hitherto, it has been believed that such processes were confined to nucleated cells. It is hoped to obtain decisive evidence of regeneration by labelling normal cells and cells treated with receptor-destroying enzyme with nitrogen-15 and determining their respective life-spans. Full details of the experiments outlined above will be published elsewhere.

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Comparison of Hydrophilic and Lipophilic Properties of Sera

There is a constant exchange of salts, water, non-electrolytes such as sugars and also substances with lipoid solubility between the blood plasma and the reticulo-endothelial system (liver, spleen). The binding power of the serum proteins for these various substances is different, and the transport capacity for any one category varies with the protein composition of the serum. If superimposed processes, like local variations of concentration and variation in the thickness of the epithelial layer, are neglected, the process can be compared with the elution of absorbed substances in a chromatographic pile.

In order to obtain standardized conditions in which the elution by blood serum of hydrophilic as well as lipophilic dyes could be measured, we prepared the following membranes: disks of 9 cm. diameter were cut from a thin membrane of animal skin ('Naturin', manufactured in Sweden, not 'Cellophane') and submerged in 30 c.c. of a solution of 2 mgm. per cent (565 γ) Evans-Blue (*T*−1824) in saline; similar solutions were prepared with Geigy Blue 536 and Congo Red. The solutions of the lipophilic dyes consisted of 30 c.c. of 2·5 mgm. per cent Sudan Red, Sudan Black and Ciba Blue B.Z.L. in 5 parts of ethyl alcohol and 7 parts of water. After 96 hr. (room temperature) the membranes had taken up quantitatively all the hydrophilic dyes and between 650 and 700 γ of Sudan Red, 380–430 γ of Sudan Black and 730–750 γ Ciba Blue B.Z.L. The exact amount could easily be determined in a photo-electric colorimeter. All the membranes were then thoroughly washed with water, in which the absorbed dyestuffs are not soluble; next they were placed in Petri dishes and carefully submerged in dilutions of the sera in saline. This dilution is so regulated that the protein content is always 1 per cent. The Petri dishes were covered and placed in the refrigerator at 2° C. for 48 hr. The dyestuff-content of the serum dilutions was then determined in the colorimeter, comparing it against the diluted but uncoloured serum. The elution attained is given in the accompanying table (p. 851). Parallel measurements are

Table 1

	1 per cent solution of	Elution in γ dye per mgm. protein or plasma substitute	
		after 24 hr.	after 48 hr.
Hydrophilic dyes			
Evans Blue	Serum	1·13	1·41
	'Subtosan'	0·78	0·87
Geigy Blue 536	Serum	1·27	1·44
	'Subtosan'	1·06	1·25
Congo Red	Serum	0·72	0·81
	'Subtosan'	0·60	0·63
Lipophilic dyes			
Sudan Red	Serum	0·14	0·17
	'Subtosan'	0·03	0·04
Sudan Black	Serum	0·49	0·55
	'Subtosan'	0·09	0·11
Ciba Blue B.Z.L.	Serum	0·40	0·48
	'Subtosan'	0·11	0·13

made with 1 per cent dilutions of the French blood plasma substitute 'Subtosan', which is based on colloidal polyvinylpyrrolidone.

It follows that the elution by serum proteins of hydrophilic dyes is between two and ten times stronger than the elution of lipophilic dyes. The elution of hydrophilic dyes is nearly equalled by the plasma substitute 'Subtosan', whereas the solution of lipophilic dyes is definitely inferior. If vitamins and hormones could be substituted for dyes, such measurements would be of pharmacological value.

In order to evaluate the binding capacity of serum proteins for the above-mentioned hydrophilic dyes, 2 mgm. per cent dye solutions in saline were prepared. To 30 c.c. of such solutions, we added as much normal blood serum as was required to bring the final protein concentration to 100, 40 and 10 mgm. per cent. After 15 min., fresh, undyed membranes were carefully submerged (wetted on all sides) and the Petri dishes placed in the refrigerator in order to lessen evaporation and contamination. Free portions of the dyes coloured the membrane; the decrease of the dyes in the diluted sera was measured in the colorimeter after 6 hr. and after 24 hr. and is given in Table 2 as a percentage of the total dye at the beginning.

Table 2

Dyestuff	Serum protein dilution (mgm. %)	Amount of dye bound after 6 hr. (%)	Amount of dye bound after 24 hr. (%)
Evans-Blue	100	0	0
	40	0	8·3
	10	11·7	20·1
Geigy Blue 536	100	0	2·6
	40	7·8	15·0
	10	30·2	44·3
Congo Red	100	5·0	8·3
	40	9·2	13·1
	10	19·3	29·1

By graphic interpolation we find that approximately 32 γ of Evans-Blue is bound per mgm. of normal serum protein; if serum of a nephrotic patient is used instead, the binding capacity is reduced by about one-third. Electrophoretic analysis of the serum proteins and the evaluation of plasma volume *in vivo* with the aid of Evans-Blue are interesting supplements to the above findings, a task with which we are actively engaged.

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Occurrence of Biotin in Seitz Filter Pad

In our tests with a strain of the fungus *Memnoniella echinata* which requires preformed biotin for growth[1,2], it was noticed that whereas no germination took place in heat-sterilized liquid Czapek–Dox medium without added biotin, appreciable growth resulted if the same medium was sterilized by Seitz filtration (using Ford's 'Sterimats' pad, grade *SB*, 6 cm., from Gallenkamp and Co.). This led to the suspicion that the filter pad might be contributing biotin, which was confirmed by the following experiments.

A medium which had successively undergone the processes of Seitz filtration and heat sterilization was found to support growth and sporulation of the fungus. Similar results were obtained when the basal medium was supplemented with a water-extract of the filter pad and then sterilized by heat. That the stimulation was due to biotin and not some other unknown factor was proved by inactivating the extract with avidin, a specific biotin antagonist. Avidin, prepared from egg-white according to Eakin *et al.*[3], was added to cooled heat-sterilized media containing varying amounts of either pad extract or pure biotin. Half the flasks in each set were autoclaved at 5 lb. for 5 min. to destroy the avidin. The figures in the accompanying table, each representing the mean of two readings, show that the active factor in the filter pad in the present case is biotin.

Glucose 5 per cent, avidin 0·5 mgm./flask, incubation at 22° C. for 14 days

Addition to basal medium	Treatment after adding avidin	Germination period, days	Final mycelial wt. (in mgm.)
Extract of ½ of a pad	Autoclaved	3	174
Same as above	Not autoclaved	No germination	—
0·001 μgm. biotin	Autoclaved	3	178
Same as above	Not autoclaved	No germination	—

Since higher doses of biotin gave increased growth under identical conditions, the biotin content of a single pad may be computed to be nearly 0·004 μgm. This value, confirmed in subsequent tests, is high enough to exert significant influence on most biotin-sensitive micro-organisms.

Since the filtration technique is not infrequently used in microbiological growth-factor work, it was felt that these results might be of interest to others.

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Role of Zinc in Metabolism

It is commonly suggested that zinc plays a part in the utilization of carbohydrate by fungi[1,2] because under conditions of partial zinc deficiency less carbohydrate is completely oxidized and a greater proportion is diverted to form organic acids.

However, the results presented in Tables 1 and 2 show that partial deficiencies not only of zinc but also of iron, copper, manganese, phosphorus, mag-

Table 1

p.p.m. of metal in the medium	Zinc		Iron		Copper		Manganese	
	Myc. wt. (gm.)	Total acidity	Myc. wt. (gm.)	Total acidity	Myc. wt. (gm.)	Total acidity	Myc. wt. (gm.)	Total acidity
0					0·250	7·5	0·29	33·5
0·005					0·310	33·0	0·359	18·3
0·01			0·135	15	0·322	24·7	0·348	17·0
0·02			0·197	30			0·374	15·2
0·05	0·150	10·1	0·264	49·6	0·362	8·2	0·372	13·4
0·1	0·230	29·9	0·328	43·7				
0·2	0·351	16·0						
0·5	0·382	5·0	0·367	13·0	0·339	4·0		

nesium and potassium have the same effect on the production of acid by a strain of *Aspergillus niger*. Surface cultures were harvested after four days incubation at 28° C. and the figures given are the average of three flasks. The medium was freed from zinc, iron, copper and manganese by shaking with chloroform solutions of 8-hydroxy-quinoline. Titratable acidity is expressed in ml. of $N/10$ sodium hydroxide.

Table 2

% of metal in the medium	Phosphorus		Magnesium		Potassium	
	Myc. wt. (gm.)	Total acidity	Myc. wt. (gm.)	Total acidity	Myc. wt. (gm.)	Total acidity
0·002					0·112	6·6
0·005	0·100	—	0·172	7·7	0·219	9·7
0·01	0·167	6·9	0·312	20·6	0·318	25·1
0·02	0·326	33·3	0·336	4·9	0·339	6·4
0·03	0·351	18·0	0·344	3·0	0·337	1·8
0·05	0·390	4·6				

The current suggestion that zinc plays a part in the utilization of carbohydrate by fungi rests on the fact that more acid is produced when zinc is partially deficient[2,3,4,5]. A deficiency of zinc undoubtedly does affect the way in which carbohydrate is utilized; but this effect is by no means specific, and the available data on zinc and organic acid production indicate no more about the role of zinc than about the role of any other inorganic nutrient.

These and other results will be presented in full elsewhere.

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Antagonism between Trypaflavine and Cations

Albert *et al.*[1] have proved the existence of a definite competition between hydrogen ions and acridine ions for the same position on an enzyme surface, which should be a negatively charged point on the bacterial surface. According to these authors, this point might be, for example, the dissociating acidic group of a respiratory enzyme.

Working with baker's yeast[2] and with *E. coli*[3], we have shown that the inhibition of respiration caused by trypaflavine is reversed not only by hydrogen ions, but also by different mono-, di- and ter-valent cations (K^+, Na^+, Mg^{++}, Ca^{++}, La^{+++}) and by non-inhibiting organic cations such as spermine[4]. In our experiments at least, it seems that a specific competition between hydrogen ions and trypaflavine ions is not the unique cause of the inhibition observed. The inhibition of respiration caused by other basic compounds (protamine sulphate, 'Paludrine', methylene blue and others) is also prevented by inorganic and non-toxic organic cations[5]. It should be noted that Silverman and Evans have observed a reversion of the inhibition of growth of *B. coli* caused by atebrin, by polyamines[6] and different inorganic cations[7]. We have found that this holds also for the inhibition of growth of *B. subtilis* caused by trypaflavine[8].

Our experiments suggest the existence of competition between trypaflavine ions and all the other cations present in the medium for negatively charged groups on the cell surface (protoplasmic membrane), the adsorption of the trypaflavine ions at these groups being the condition of their entrance into the interior of the yeast cell, where they would exert their inhibiting activity.

We have now tested this hypothesis by studying the influence of quaternary ammonium salts on the inhibition of respiration of baker's yeast caused by trypaflavine. As quaternary ammonium salts we used the series R trimethyl ammonium chloride, in which R ranged from C_3H_8 up to $C_{16}H_{33}$; we experimented also with 'Cetavlon'. Oxygen uptake was measured at 28° C. by the usual Warburg method, the vessels containing 2 ml. of fluid composed as follows: 1 ml. of a 1 per cent suspension of baker's yeast in $M/15$ phosphate buffer, pH 6·2; 0·1 ml. 4 per cent glucose and 0·9 ml. of water or trypaflavine respectively (end concentration $M/5{,}000$) and/or a quaternary ammonium salt.

From our results it appears that the surface-active ammonium salts, which are strongly adsorbed at the cell surface, prevent even in low concentrations the inhibition of respiration by trypaflavine. Of course, the ammonium salts were used at concentrations at which they are not toxic themselves. We have found, for example, that in the presence of $2{\cdot}5 \times 10^{-5}$ M 'Cetavlon' and of 1×10^{-4} M tetradecyltrimethylammoniumchloride, $M/5{,}000$ trypaflavine does not bring about the slightest inhibition of respiration under the conditions of our experiments. The quaternary ammonium salts of our series, with R up to and including C_5, being much less surface-active or not active at all, also do not prevent the inhibition of respiration, at least at low concentrations.

Our results on respiration have been corroborated by measuring the uptake of trypaflavine by baker's yeast in the conditions of our respiration experiments. They show that this uptake is definitely lowered in the presence of the surface-active ammonium salts.

Extending our experiments to the uptake of trypaflavine by suspensions of dead yeast cells, we have observed that, at the dilutions used in our experiments on living cells, the quaternary ammonium salts are poor competitors and are practically unable

to displace the trypaflavine. This seems to confirm our hypothesis that the competition between quaternary ammonium salts and trypaflavine takes place for positions on the cell surface commanding the entrance of trypaflavine in the cell. The same kind of experiments with spermine and inorganic cations instead of the quaternary ammonium salts suggests that here, too, the activity of these cations in preventing the inhibition of respiration by trypaflavine is due to competition for negatively charged groups of the cell surface. Our present experiments have also confirmed the high affinity of trypaflavine for nucleic acids we have described in earlier papers[2-4].

Our observations on the inhibition of respiration by baker's yeast and the prevention of this inhibition by all kinds of cations not themselves inhibitors, together with the laws governing this prevention (importance of valency of inorganic cations[2], surface-activity for quaternary ammonium salts), suggest that: (1) trypaflavine is adsorbed at the protoplasmic membrane by acidic groupings prior to its entrance in the yeast cell; (2) this adsorption can be prevented by other cations which are bound by the same acidic groupings by means of Coulomb forces, and that competition for these groupings takes place (cation exchange); (3) trypaflavine exerts its inhibiting activity in the interior of the yeast cell.

Full details of these experiments will be published elsewhere.

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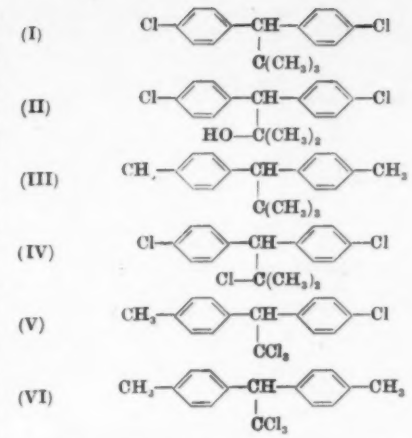
Insecticidal Action of DDT

Since the discovery of the outstanding insecticidal activity of 1 : 1 : 1-trichloro-2 : 2-di-(4-chlorophenyl) ethane (DDT), many analogues have been synthesized, and several investigators[1,2] have reached the conclusion that the most toxic are also the most similar to DDT in shape and size. If the toxicity is due to its structural resemblance to some essential insect metabolite or to cholesterol[3], then compounds isosteric with DDT ought to act similarly, and replacement of the three β-chlorine atoms by spatially similar atoms or groups of atoms should not destroy activity. Suitable groups were thought to be $-CH_3$ (radius 1·7 A.) and —OH (radius 2·0 A.), which conform reasonably well with Cl (radius 1·7 A.)—an agreement which has been shown[4] to be well within the limits required for isosteric activity in serological reactions.

Accordingly, compounds I, II, III and IV were prepared and tested against *Calandra granaria* L.[5]. All showed little or no activity as contact insecticides.



This is significant in view of the fact that (V) and (VI) are also isosteric with DDT, but are appreciably insecticidal[6,7]. Whether this is due to their ability to lose hydrochloric acid[8] or to some intrinsic property of the $-CCl_3$ group[9] is still obscure, though the former possibility seems less probable in view of the inactivity of (IV), which becomes dehydrochlorinated readily to a mixture of ethylenes.

Further work is in progress and will be fully reported elsewhere.

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Substances with Fungicidal Activity in the Bark of Deciduous Trees

Some years ago it was found that the bark of the balsam poplar *Populus candicans* contains substances with fungistatic activity, and that these substances can be isolated from the bark by extraction with boiling water[1].

Further investigation has made clear that the extract can be concentrated by evaporation of water at boiling point, without loss of activity. When added in sufficient concentration to a nutrient agar, the growth of *Stereum purpureum* on it was completely inhibited, and the fungus died. The action is therefore not only fungistatic, but also fungicidal.

Other species of the genus *Populus* have been tested; first of all the balsam poplar *P. trichocarpa*, which gave extracts with fungicidal activity as strong as *P. candicans*. The bark of *P. monilifera*, *P. robusta*,

P. Fremontii, *P. Wislizenii* and *P. Eugenii* showed only very weak fungicidal activity; it seemed first that the activity was restricted to the balsam poplars; but recently *P. regenerata*, *P. serotina erecta* and *P. marilandica* were found also to give active extracts.

The bark of *Alnus glutinosa*, *Fagus sylvatica* and *Quercus pedunculata* showed (in the winter) almost no activity at all.

The leaves of *P. candicans* showed also fungicidal activity, though weaker than the bark of this species.

Fungicidal activity of plant extracts is not uncommon, but in general the leaves show more activity than the bark[2]. In trees of the genus *Populus* the distribution of inhibitors in the plant seems to be different.

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Proliferative Capacity of the Hypophysial Portal Vessels

The pathway by which the hypothalamus influences the secretion of the anterior pituitary gland has been the subject of much research. The possibility that the hypophysial portal vessels may form part of this pathway has been discussed[1], and the anatomy of these structures in the rat and other forms has been described. In 1949, Harris[2] observed that regeneration of the hypophysial portal vessels in the rat may follow section of the pituitary stalk, and later[3] that post-operative return of reproductive activity can be correlated with such regeneration. In this work the hypophysial stalk was exposed by the subtemporal route and either cut with a knife or torn with a hook. In the literature, accounts of stalk section made by a variety of methods show divergent results. Since the conditions for a regeneration of the portal vessels may vary according to the method used for severing the hypothalamo-hypophysial connexions, we have investigated the regenerative capacity of these vessels in different circumstances.

Regeneration of the hypophysial portal vessels and the state of the endocrine glands have been studied in rats. The experiments are divided into four groups:

(1) Hypophysectomy and transplantation of anterior lobe tissue under the median eminence (12 experiments).

(2) Hypophysectomy and transplantation of the extirpated anterior lobe into the emptied hypophysial capsule (16 experiments).

(3) Extirpation of the anterior pole of the hypophysis (13 experiments).

(4) Section of the hypophysial stalk (25 experiments).

Twelve hypophysectomized rats served as control material. The duration of the experiments varied from 1 to 104 days.

The observations show that a hypophysial transplant near the hypophysial stalk *in the subarachnoid space* becomes richly vascularized from the portal vessels. Regeneration of the portal vessels after stalk section by the sub-temporal route has been confirmed, and previous studies of the activity of the anterior lobe[3] extended. It seems clear that in the subarachnoid space the portal vessels can undergo proliferative and reparative changes. Further work is in progress concerning the cytology and activity of these transplants.

The evidence obtained from the experiments on rats with a transplant in the hypophysial capsule, and on rats with the anterior pole of the hypophysis removed, indicated that capillaries derived from the portal vessels may invade such isolated anterior lobe tissue *in the capsule*. However, anterior pituitary tissue transplanted into the capsule did not become vascularized or active. Since the possibilities of obtaining living transplants of anterior lobe tissue inside the hypophysial capsule are highly dependent on technical factors, other techniques are being investigated.

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Autonomic Nervous System of the Ratfish

Detailed accounts are available for the autonomic nervous system of various Selachians[1–4], but little is known of the same system in the Chimæroid fishes or Holocephali. To remedy this defect a study has been made of the autonomic nervous system of the Chimæroid *Hydrolagus colliei*. This species is common in British Columbian inshore waters[5].

The autonomic system of *Hydrolagus* comprises a sympathetic portion in the trunk, and a parasympathetic cranial portion. In the sympathetic system, segmentally arranged vertebral ganglia occur from the level of the heart to the anus. The ganglia are closely associated with small suprarenal bodies, and they are connected together by a loose plexus lying in the dorsal body wall. A regular chain and commissures between ganglia are absent. The largest ganglia are the gastric ganglia; these are joined to large masses of suprarenal tissue on the subclavian arteries. White rami communicantes connect the sympathetic ganglia to the spinal nerves. The sympathetic ganglia give rise to visceral nerves supplying blood vessels, genital ducts, suprarenals, intestine, liver and pancreas. A sympathetic extension into the head and tail is absent, and there is no sympathetic innervation of the heart.

The parasympathetic system lies in a midbrain and a hindbrain outflow. The former passes through the oculomotor nerve to an adherent ciliary ganglion; from the latter, short ciliary nerves proceed to the eyeball. The hindbrain outflow comprises ganglia in the glossopharyngeal and vagal nerves. The vagus also supplies the heart and intestine, and connects with the sympathetic system. A true sacral parasympathetic system is wanting; but motor fibres from posterior abdominal spinal nerves directly innervate smooth muscle of the rectum without the interpolation of post-ganglionic neurones.

The autonomic nervous systems of Selachians and Chimæroids are remarkably similar, despite the fact that the two groups have preserved an independent evolution since the Palæozoic[6]. It would appear that this kind of autonomic system represents a simple level of organisation present in the common ancestor

of extant elasmobranchs (Holocephali and Euselachii). These dual lines of evidence point to the primitive and non-specialized character of this autonomic nervous system, which reflects a stage in the evolution of the autonomic systems of Teleostomes and Tetrapods.

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Photoperiodic Induction and the Development of Growing Apex in Rice

The inflorescence of rice is a panicle; its development is different from that of the spike of cereals studied by Purvis[1] and Bonnet[2,3]. It has been noted by Purvis[1], Purvis and Gregory[4], Bonnet[2,3] and Sharman[5] that the development of a spike is preceded by the formation of double ridges on the main rachis; one of the ridges forming into a spikelet and the other a subtending bract under an effective photoperiod and with low temperature of germination. In the absence of these conditions the primordia grow into leaves. The whole theory of the hormonal mechanism of flowering by Purvis and Gregory is based on this fundamental fact. The behaviour of rice is different from that of rye in several important aspects. The effect of short days on rice is quantitative in its flowering response[6]. While in winter rye Purvis and Gregory have observed that short days up to six weeks accelerate flowering and that subsequent long days are essential. Exposure to short days for periods longer than six weeks retards flowering. Tillers in rye show the same behaviour as the main shoot, indicating that the whole plant is affected by the treatment, although at the end of the treatment the majority of the vegetative buds are not yet formed. In rice (var. Rupsail) the tillers behave differently from the main shoot in respect of their leaf number and ear emergence by short-day exposure. The growing apex in its transition from vegetative growth to reproduction elongates considerably at the top, and along the edges several small groups of cells protrude which ultimately develop into branch rachides bearing more than one spikelet. Nowhere in the present investigation have double ridges, as noted in wheat, barley and rye, been seen. With an adequate dose of photoperiodic treatment the vegetative apex gradually passes into a main rachis bearing branches on which spikelets are formed. Once the rachis is formed under short-day conditions it continues to form spikelets irrespective of subsequent long days. The photoperiodic stimulus acts quantitatively on the growing apex. A minimum of four weeks exposure is necessary for 100 per cent flowering of the main shoot; after three weeks 66 per cent, and two weeks 3 per cent flower. In the case of first and second tillers six weeks are essential. Anatomical changes in the growing apices reveal that after four weeks all the vegetative apices are transformed into inflorescences; after three weeks some apices are reproductive and others remain vegetative all through.

In a previous paper[7] a lag in the flowering of the tillers has been noted, and this was suggested to be due to the absence of the stimulus in the growing apices of the tillers. Observation of histological changes in the growing region has now substantiated this assumption. It has been noted that only two tiller buds are formed during the periods of six weeks short-day exposure. The tillers formed from these buds flower later than the main shoot but much earlier than the other tillers of the same plant.

Considering the results so far obtained with rice in this laboratory, it is apparent that prior to the initiation of flower primordia, development of the primordia to spikelets and differentiation and normal development of the floral organs, photoperiodic induction involves a series of chemical reactions, presumably by the participation of a hormone or hormones. That the treatment provokes considerable changes in the metabolites is evident from the results noted previously[8,9]. With the data obtained, it is not possible to formulate the different reactions involved in the flowering of rice similar to those formulated for winter rye by Purvis and Gregory and for *Xanthium* and Biloxi soybean by Hamner[10]; further work is necessary. It is admittedly a fact that generalization with respect to the possible action of flowering-hormone is difficult because of variations in response in different plants under varying environmental conditions.

A full report of this work will be published elsewhere. We desire to thank the University of Calcutta for offering facilities for carrying out this investigation in the Department of Botany.

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Flow of Momentum and Mass across the High-Pressure Belt of the Earth's Atmosphere

The atmospheric angular momentum generated at the earth's surface between latitudes $\pm \varphi$ must, over a long period, be balanced by an equivalent outflow of angular momentum across these parallels. It was argued by Jeffreys[1] that the main agents of this efflux are rotations of cyclonic dimensions lying side

by side, at least in the latitudes of the prevailing surface westerlies. Extended to all latitudes, this view encounters the difficulty that the maximal flux must occur across the belts of minimal disturbance around lat. 30°–35° N. and S.; nevertheless, it is widely held that this is effected by a marked horizontal asymmetry in the anticyclones comprising the high-pressure belt.

There is no published quantitative evidence to show that horizontal rotations constitute the sole or even the principal agency of momentum exchange across the 'horse latitudes': and there must remain a strong possibility that dynamically important variations in flux may well be due to variations in other agents the contribution of which is not of an altogether lower order of magnitude.

The view here advanced is that a significant net efflux of angular momentum, Ω, is effected by a mean poleward drift of air at some levels, accompanied by an equivalent mass drift equatorward at others, that is, by the components in meridional planes of a mean toroidal circulation. Denoting the mean speed of westerly wind and poleward drift at pressure-level p by $\bar{u}$ and $\bar{v}$ respectively, the mean poleward flux of angular momentum across φ can be shown to be

$$\frac{2\pi R^2 \cos^2 \varphi}{g} \int_0^{p_0} \bar{v}\bar{u}\, dp,$$

where R is the earth's radius and p_0 denotes surface pressure. The total angular momentum generated by surface friction between the equator and latitudes 30° in a year is estimated as $1{\cdot}3 \times 10^{34}$ gm. cm.^{2}/sec. or more. Equating these two, it appears that a poleward drift through the strong-wind levels of upper troposphere and lower stratosphere in this latitude need be of mean magnitude only a few miles per hour in order to effect the necessary efflux of angular momentum. An *ad hoc* analysis by me of surface-wind data has indicated a mean equatorward drift of 2 m.p.h. across the latitude of maximal mean pressure. Similar attempts to identify an opposite drift at upper tropospheric and lower stratospheric levels have proved inconclusive; but there is a concordant body of less direct evidence that such a drift does, in fact, take place.

Quite apart from a net drift which may result from thermodynamic requirements[3] or a patterned horizontal acceleration[2], a motive influence is to be found in the occurrence of strong anticyclonic wind shears around 8–15 km., which become unstable when $\partial\Omega/\partial\varphi > 0$. If this condition is approached predominantly to equatorward of the latitude considered, the mean resulting drift would be poleward at the levels of strongest wind. On this explanation the drift is to be pictured as of fluctuating strength.

Jeffreys[4] has indicated that the surface circulation will tend to be annihilated by friction in about twelve days; but this is on the assumption that the angular momentum generated at the surface is equally redistributed through the overlying layers. It appears more probable that, especially in winter, the angular momentum generated in the tropical belt will show a tendency to accumulate in upper tropospheric layers. The decline in the surface circulation will thereby be retarded while dynamical instability may develop aloft; I have estimated that this will take of the order of three or four days from an initial state identified with the mean u,φ distribution. When instability supervenes, angular momentum is released to higher latitudes in outbursts which are to be associated with the meanderings of the belt of strongest upper westerly winds or 'jet stream'. A process of adjustment and vertical redistribution of the angular momentum so released will act in such a sense as to revive the declining surface zonal circulation. It is significant that the estimated time required to develop instability from the mean state is comparable with the quarter-period of observed fluctuations in the zonal index[5]. The theory which emerges, to be published later in greater detail than is here possible, invokes the drift as a dynamic link between index fluctuations and the fluctuations in strength and in latitude of the jet stream.

The flow of angular momentum across latitude 30° effected by horizontal rotations has been assessed by a direct technique described elsewhere[6]. Evaluations based on the best data available amount to but a fraction of the $1{\cdot}3 \times 10^{34}$ gm. cm.^{2}/sec. annually generated towards the equator. Rotations in meridional planes, which must be manifest as one or more layers of drift and counterdrift, constitute the only alternative agency of momentum efflux which satisfies the necessary condition of zero net flow of mass.

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An Electron-Beam Decimal-Counter Tube

Sealed-off models of a successful scale-of-ten counter electron tube have been completed in this laboratory. The objective has been to develop a small single-tube decade which would operate at a low anode voltage and indicate the count by displaying numbers projected electronically on a fluorescent screen at the end of the bulb.

Counting is accomplished by stepping a deflected electron beam through a cycle of stable positions, and the basic principle may be explained as follows. Consider a series of deflector plates and collector segments, spaced evenly around the axis of the tube and interconnected so that each deflector is joined to the collector segment 180° ahead, and through a series resistance to the positive of a D.C. supply. Interception of the beam by a segment will lower the potential of the opposite deflector and cause the beam to move radially outwards across the segment. However, if the angular phase difference between segment and deflector is other than 180°, a continuous rotation of the beam can be produced, the direction depending on whether the phase is greater or less than 180°.

The counter shown in section in Fig. 1 makes use of a set of five deflectors (K), interconnected with a front group of five segments (O) phased for forward

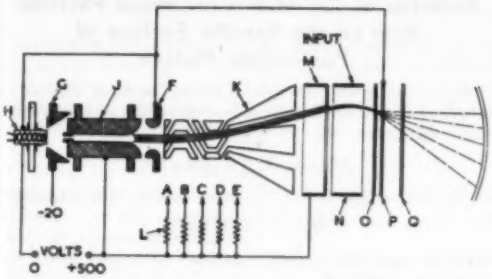

Fig. 1. Counter-tube electrode system in section: *H*, cathode; *G*, grid; *J*, anode; *F*, focusing electrode; *K*, five deflectors; *M*, positive ring; *N*, trigger ring; *O*, front segments; *P*, suppressor; *Q*, back segments

rotation, and a back group (*Q*) phased for reverse rotation.

Openings are cut in the front segments as shown in Fig. 2. At the leading edge of each radial slot, stable regions are formed where the opposed rotational tendencies balance, and the resultant deflexion is purely radial. The beam, falling in one of the stable regions, therefore moves outward until its partial interception by the positive ring *M*, Fig. 1, causes a reduction in the current reaching the segments and therefore also in the deflecting potentials. A position of equilibrium is thus established, in which the beam is partly intercepted by the positive ring, the radius of which therefore determines the radial deflexion of the beam. Radial movement of the spot on the front segments occurs only when the potential of the axially symmetric trigger electrode (*N*) in Fig. 1 is changed by the input signal.

At the count of 1, the beam is assumed to be in the stable position marked 1 in Fig. 2. A positive-going signal applied to the trigger moves the spot outwards to the limit of the inner radial opening in the front segment. Further movement increases the front-segment current until the beam becomes unstable and rotates forward to the next outer stable edge marked 1½ in Fig. 2. As the signal falls, the spot moves inwards from the inner limit of the 1½ state and rotates forward to the inner state 2. Ten input signals cause the beam to rotate one complete forward revolution through twenty stable states.

Because two stable states are used for each count, there is no upper limit to the duration of the input impulse.

Secondary emission from the front segments is prevented by the trigger, and between front and back groups of segments by the suppressor *P* (Fig. 1). Some exchange of secondaries between adjacent segments is used in both groups to develop voltage wave-forms corresponding to a smoothly rotating deflexion field. The suppressor is shaped also to diverge the transmitted beam sufficiently to project on the fluorescent end of the bulb enlarged visible images of numbers cut in the back segments. These images are 12 mm. high, the enlargement in projection being 8 diameters.

The tube is 2·9 cm. in diameter and 15 cm. long. The five deflector resistances are attached to the octal base. The tube operates at 500 volts with a beam current of 300 microamp. The frequency-range is from zero to 68 kc./s. with deflector resistances of 1½ megohms. Counting is independent of the value of these resistances within the range 2–12 megohms.

The possibility is being investigated of increasing the beam current and raising the upper frequency limit, so that the tube may be applied to a wider range of electronic counting and computing operations.

This work forms part of the research programme of the Division of Electrotechnology, Commonwealth Scientific and Industrial Research Organisation. The operating principle was originated in 1947 in collaboration with Mr. A. M. Thompson of that Division. I wish to acknowledge the continued interest and encouragement of Prof. D. M. Myers. A more detailed description will be given elsewhere.

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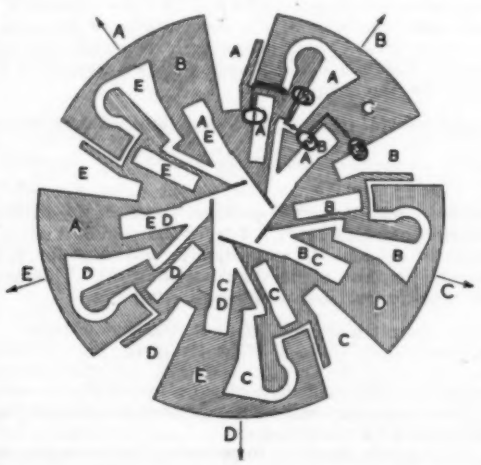


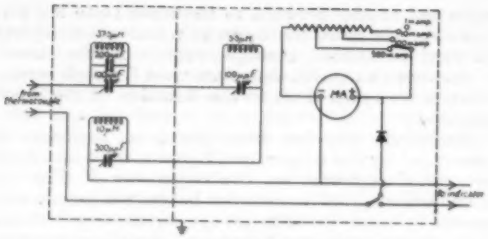
Fig. 2. Front collector segments. The arrows show the directions of beam deflexion for each of the five deflectors

A High-Frequency Current Filter in a Thermo-electric Circuit for Temperature Measurement

When using high-frequency heating methods the thermo-electric measurement of temperature is difficult because of stray high-frequency current picked up in the measuring circuit.

This problem was encountered in some investigations at these laboratories in which small, hollow steel specimens are heated in an enclosed space by means of a high-frequency heating coil (1 kVA.). The most convenient method for measuring temperature involves the use of a thermocouple, the hot junction of which is welded on the inside of the steel specimen, so as to screen it from direct induction heating. However, it was found that quite large and variable high-frequency currents of the order of 100 milliamp. may be present in the measuring circuit.

These stray high-frequency currents are not, of course, registered on the D.C. millivoltmeter used for measuring the thermal E.M.F., but there is the danger that the total current will be sufficient to burn out



Circuit diagram for radio-frequency suppressor

the field coil of the millivoltmeter. The particular instrument used shows full-scale deflexion for about 3·5 milliamp., so that the presence of additional high-frequency current of the order of 100 milliamp. represents a considerable overload.

We have been concerned with rapid changes in temperature, in some cases imitating the rapid heating and cooling cycle in a weld. For this purpose a rapid-response millivoltmeter is required, which itself has a low internal resistance (9·7 ohms), and necessitates a low fixed resistance in the external circuit (6 ohms). The problem resolves itself into devising a low-resistance circuit which will filter out the high-frequency current.

A circuit found suitable for the purpose is shown in the accompanying diagram. The method uses the well-known filtering device of a parallel-tuned circuit consisting of a coil and condenser, which resonates at the frequency which it is desired to reject by presenting an infinite impedance to currents of this particular frequency. Preliminary tests showed that the principal frequencies to be filtered were approximately 1·5, 3 and 9 Mc./s., and, using these figures, appropriate values for the inductances and capacitances were selected.

When measurements are being made, a mock thermocouple is used with two similar wires, to ensure that no direct current is flowing. The residual high-frequency current is measured after rectification on a four-range milliammeter. Following a suggestion of Mr. D. A. Furzey, of the General Electric Company, Ltd., a germanium-type rectifier (*C.V.*102) was used and found to have a reasonable life under these conditions. The assembly is enclosed in a metal box provided with three tuning dials. The box serves as an earthed screen. In addition, some internal screening was found necessary to prevent interference between the tuning circuits. Connexion to the indicating millivoltmeter is made through earth-screened cable. In normal use, the leads from the thermocouple are in direct connexion with the millivoltmeter through the filter unit, but a switch is provided so that an occasional check can be made on the residual high-frequency current through the milliammeter and rectifier.

It was found possible to limit the maximum residual current to a fraction of a milliampere, though the total resistance of the unit was only 1·9 ohms.

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Relation of the Harmonic Mean Particle Size to the Specific Surface of Particulate Matter

Since both the harmonic mean particle size of a powder—number distribution—in terms of the equivalent diameter, d_i,

$$M_h = [1/N\,\Sigma(1/d_i)]^{-1},$$

or, in the notation for the expectation of a quantity,

$$M_h = [E(1/d_i)]^{-1},$$

and its specific surface (surface area per gm.) for spherical particles

$$S_w = 6/\rho M,$$

where M is an average particle size, and ρ the density of the material, are functions of $1/d_i$, it is sometimes assumed that the reciprocal of the harmonic mean $1/M_h$, and the reciprocal $1/M$ in the formula for the specific surface, are more or less identical[1].

This is, however, not the case unless all particles are of exactly the same size, and thus form a strictly monodisperse powder. In general, the two reciprocals are not equal, the difference being systematic and dependent upon the variability of particle size. The proof is as follows.

Considering that $d_i^3 n_i / d_i^3 n_i = 1/d_i$, we can express the reciprocal of the harmonic mean as the expectation of the ratio of two powers of d_i:

$$1/M_h = E(d_i^3 n_i / d_i^3 n_i).$$

On the other hand, the quantity M in the expression for the specific surface has the structure

$$\Sigma d_i^3 n_i / \Sigma d_i^3 n_i,$$

and is, therefore, called the volume-surface diameter, and can be written as

$$M_{vs} = \frac{\Sigma d_i^3 n_i / N}{\Sigma d_i^3 n_i / N} = E(d_i^3)/E(d_i^2),$$

which expresses M_{vs} as the ratio of the expectations of d_i^3 and d_i^2.

$1/M_h$ then appears to be the expectation of the ratio of the two functions d_i^3 and d_i^4 of the variable d_i, and $1/M_{vs}$ the ratio of the expectations of the same two functions. Their values will, as a rule, not be equal. The relations between the two quantities is given by the inequality[2]

$$| 1/M_h - 1/M_{vs} | = | E(1/d_i) - E(d_i^3 n_i^3)/E(d_i^3 n_i^3) | \leqslant \frac{K\sigma(d^3) + \sqrt{\sigma(d^2) + \sigma(d^3)}}{[M_d^3]^2},$$

where K stands for the greatest value of $1/d_i$ in the distribution, and $\sigma(d_i^3)$, $\sigma(d_i^2)$ for the standard deviations of d_i^3 and d_i^2 respectively, and M_d^3 for the arithmetic mean of the distribution of d_i^3. This can be transformed[3] into

$$\left| \frac{1/M_h - 1/M_{vs}}{v^2} \right| \leqslant \frac{\sigma(d^2)}{\sigma(d^3)},$$

where v is the coefficient of variation of d^3.

The inequality will be the greater the greater the variability of particle-size.

This result acquires importance, for example, in the application of the Kozeny equation for the permeability constant of particulate matter[4]:

$$K = \frac{c.\,l_s/l_w\,.\,p^3}{(1-p)^2\,.\,S_v^2} = \frac{l_s/l_w\,.\,p^3\,.\,d_w^2}{(1-p)^2\,.\,36},$$

where p is the porosity, S_v the specific surface per c.c., $c.\ l_s/l_w$ a constant dependent upon the shape of the capillaries, and d_w is what Kozeny calls the "effective diameter", and what we call the "volume-surface diameter", which he calculates as

$$1/d_w = \int dG/d_i,$$

where G is the weight of the grain mixture (p. 305, ref. 4), taken as unity.

Thus, Kozeny calculates d_w as the harmonic mean of the weight distribution.

Since

$$\frac{1}{d_w} = \Sigma \frac{1}{d_i}\frac{dG}{G} = \frac{\rho \Sigma \frac{1}{d_i} d_i^3 n_i}{\rho \Sigma d_i^3 n_i} = \frac{\Sigma d_i^2 n_i}{\Sigma d_i^3 n_i} = \frac{1}{M_{vs}},$$

where ρ is the density, d_w equals the volume-surface mean of the Kozeny equation. But, except for the case of a monodisperse aggregate—where we cannot speak of an average at all—the quantity d_w in the equation for the permeability constant as the volume-surface diameter of the structure $\Sigma d_i^3 n_i / \Sigma d_i^2 n_i$ can differ considerably from the harmonic mean of the number distribution.

That Kozeny was not aware of the distinction between the two averages, and really worked with the number harmonic mean instead of with the volume-surface diameter, can be seen from his table on p. 306 (ref. 4). He there calculates $1/d_w$ for the class intervals of particle-size according to the formula for the number harmonic mean, as the observed value with which to compare the theoretical value of $1/d_w$ obtained from his equation (36), where d_w has the same structure as in the fundamental equation for the permeability constant.

That there is not more discrepancy between the two sets of values for d_w is due to the fact that the size intervals are so small as to approximate to monodisperse aggregates. In the case of a polydisperse aggregate, the substitution of d_w calculated as the harmonic mean into the formula for the permeability constant, where d_w appears to the second power, could lead to very wrong results.

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Bis-Ethylene-Dichloroplatinum

Zeise's salt, $K[C_2H_4PtCl_3]$, has been known since 1830[1], and dichloro-*bis*-ethylene-$\mu\mu'$-dichlorodiplatinum, 'ethylene platinous chloride' $(C_2H_4PtCl_2)_2$, was characterized by Anderson[2] in 1934; but attempts to prepare *bis*-ethylene-dichloroplatinum, $(C_2H_4)_2PtCl_2$, have hitherto been unsuccessful[3,4]. Anderson[4] has, however, reported slight evidence, which was rejected by Hel'man, for a simple *bis* styrene complex.

In this respect, olefine platinous chloride complexes are exceptional, for in every other case of the co-ordination of a neutral ligand to platinous chloride the non-ionic complex, L_2PtCl_2, is known (L = ligand), and when the ionic or bridged complexes are also known, these are as a rule less stable. Notable exceptions to this second generalization are the complexes where $L = PF_3$ and $L = CO$. Both of these readily decompose thermally at 100–150° C. with loss of the ligand to produce the very stable bridged complexes:

$$2L_2PtCl_2 \rightleftharpoons (LPtCl_2)_2 + 2L.$$

We now find that olefine complexes are extremes of this latter type. When ethylene was passed through a strong solution of ethylene platinous chloride in dry acetone or methylethylketone cooled to −70° C., a canary-yellow crystalline solid of the composition $(C_2H_4)_2PtCl_2$ separated. It was almost insoluble in the ketone at −70° C. but dissolved to give a yellow solution when the reaction mixture was allowed to warm to above −50° C. From Hel'man's work on substitution in the olefinic platinous complex series, this yellow complex would be given a *trans* configuration, and its instability can be explained as the sum of the rather weak co-ordinating affinity of ethylene, together with the strong labilizing effect of an ethylene molecule on the group in the *trans* position to itself.

The yellow $(C_2H_4)_2PtCl_2$ is very unstable, and on slowly warming to about −10° C. in an ethylene atmosphere it starts to revert to the orange $(C_2H_4PtCl_2)_2$, then on cooling again it is reconverted, at least on the surface, to the yellow $(C_2H_4)_2PtCl_2$. Even at −70° C. the second molecule of ethylene may be driven from a suspension of the yellow solid in acetone by passage of carbon dioxide, when the suspension dissolves gradually and completely in the form of $(C_2H_4PtCl_2)_2$.

Solid ethylene platinous chloride shows no evidence of combination with either liquid or gaseous ethylene at low temperatures, and the ketone appears to facilitate the reaction by opening up the bridge; in confirmation, we have found that ethylene platinous chloride has a molecular weight corresponding to $(C_2H_4PtCl_2)_2$, and not the dimer in boiling acetone solution.

A second solid of exact composition $(C_2H_4)_2PtCl_2$ + 10·75 per cent Pt which effervesces at once with potassium cyanide solution in the manner characteristic of ethylene platinous complexes has been obtained in very small quantities as a minor product of the reaction of tri-*n*-propylphosphine (2 mol.) on ethylene platinous chloride (1 mol.) in acetone solution at −70° C. It separates slowly after the reaction mixture has warmed to room temperature and is an 'off-white' amorphous-looking solid which is insoluble in all solvents tried and blackens at 150–160° C. This may be *cis*-$(C_2H_4)_2PtCl_2$, but it could be a polymeric substance.

One of us[5] has recently reviewed critically the structures proposed for olefine complexes and, with the exception of Hel'man's structure[6], based on the apparently established fact that simple non-ionic olefine platinous complexes do not exist, most of these could be rejected and the remainder shown to be improbable. Hel'man's structure, in the terms in which she conceives it, may now be rejected; but the existence of *bis*-ethylenedichloroplatinum does

not vitiate the view that *d*-orbitals may be involved in olefine co-ordination.

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Pyrolysis of 1.2 Dichlorethane

THE kinetics of the pyrolysis of 1.2 dichlorethane have recently been described by Barton and Howlett[1]. Over the temperature-range 360°–480° C. they find that the reaction is first order and proceeds by a radical chain-mechanism in vessels coated with a carbonaceous film ($k = 10^{16\cdot81} \exp -47{,}000/RT$). Strong evidence for the radical nature of the decomposition is provided by the powerful inhibiting effect of propylene. The maximally inhibited rate, which is independent of further increase in propylene concentration, is shown to be partially heterogeneous in character.

Almost simultaneously, Baldt and Cremer[2] have published an account of a similar investigation which led to different conclusions. They claim that the graph of log k against $1/T$ is sharply segmented corresponding to a heterogeneous reaction ($k = 10^{4\cdot18} \exp -28{,}100/RT$) from 377° to 415° C., and from 415° to 442° C. to a unimolecular process ($k = 10^{15\cdot70} \exp -64{,}500/RT$). (The graph does not, in fact, correspond to the data quoted in a table. Accepting the latter, the activation energy for the heterogeneous process becomes $\sim$ 25,500 cal./gm. mol.)

This result does not, in fact, follow from the Arrhenius plot, for it is easily seen that neither of these two reaction-rates is negligible in comparison with the other at any point of the narrow temperature-range studied. Thus the operation of these two reactions would lead to a continuous curve for the Arrhenius plot, and furthermore the value of log k at 415° should be 0·3 units above the point of intersection of the limiting straight lines, because the observed velocity constant would be the sum of the two (equal) constants for the alternative reactions. (This assumes that reaction does not greatly disturb the equilibrium between normal and activated molecules.) However, the experimental points lie on excellent straight lines with a point actually at the intersection. This is difficult to interpret.

It is noteworthy that at 442° C. (where direct comparison is possible) the rate constant quoted by Baldt and Cremer is intermediate between the values given by Barton and Howlett for the normal and maximally inhibited reactions. Coupled with the fact that the pyrolysis is notoriously sensitive to trace contaminants[3], this suggests that Baldt and Cremer may have been observing partially retarded decompositions. The latter give the impression that their rates are obtained for reactions in clean glass vessels, but it is most probable that they refer to product-fouled surfaces. Thus their rates are slower than those of Barton and Howlett, who report the accelerating effect of clean glass surfaces[4].

The question of the nature of 1.2 dichlorethane decomposition is an important one. The fact that it proceeds by a radical mechanism, whereas 1.1 dichlorethane decomposes unimolecularly, is strong evidence for the predictions put forward correlating structure and mode of decomposition in chlorohydrocarbon pyrolyses by Barton, Onyon and Howlett[5]. Experiment has so far verified these predictions[6].

A significant difference between the two experimental techniques lies in the method of pressure measurement used to follow reactions. Barton and Howlett used an all-glass Bourdon gauge, whereas the other authors employed a heated mercury capillary manometer. Mercury is known to inhibit the analogous decomposition of ethyl bromide[7], and would be expected to react with chlorine atoms under the experimental conditions, thus suppressing any tendency towards radical mechanisms.

I have therefore carried out further experiments in a new apparatus, using an all-glass pressure-measuring system to follow the reaction. In addition, a heated 1-mm. capillary tube containing mercury could be connected to the reactor, or isolated by a tap, so that decompositions in the presence or absence of mercury could be studied at will. General experimental procedure was as described previously[1].

In the absence of mercury, the new experiments have amply confirmed the results of Barton and Howlett for both clean and coated vessels. Furthermore, mercury vapour has been shown to inhibit the reaction. The runs were carried out using the mercury capillary heated to 120° C., at which the vapour pressure of mercury is approximately 0·8 mm. Actual determination of the rise in pressure on opening the evacuated reactor to the capillary gave a value of 0·5 mm. The results obtained in a coated vessel are summarized in the accompanying table.

Temp.	$(CH_2Cl)_2$ alone			$(CH_2Cl)_2$ + Hg	
	No. of runs	$10^4 \times$ mean k	$10^4 k$ (B. and H.) (ref. 1)	No. of runs	$10^4 \times$ mean k
435° C.	3	1·71	1·99	4	1·31
447° C.	9	3·53	3·46	7	2·55
459° C.	3	6·49	6·57	3	5·47

All rates are expressed in units sec.$^{-1}$.

The first day's experiments with a clean 'Pyrex' reactor gave a mean $k = 3{\cdot}3 \times 10^{-5}$ sec.$^{-1}$ at 408° C., in good agreement with the dynamic results of Barton[5].

The retardation of the homogeneous pyrolysis by traces of mercury vapour provides further evidence of the radical nature of the decomposition, and it must be concluded that the results of Baldt and Cremer refer to partially inhibited reactions.

K. E. HOWLETT

Bedford College,
London, N.W.1.
Jan. 26.

[1] Barton, D. H. R., and Howlett, K. E., *J. Chem. Soc.*, 155 (1949).
[2] Baldt, R., and Cremer, E., *Monatsh.*, **80**, 153 (1949).
[3] Biltz, H., and Kuppers, E., *Ber.*, **37**, 2398 (1904). Barton, D. H. R., *J. Chem. Soc.*, 148 (1949). Howlett, K. E., Ph.D. thesis, London (1948).
[4] Compare Barton, D. H. R., and Onyon, P. F., *Trans. Farad. Soc.*, **45**, 725 (1949).
[5] Barton, D. H. R., Onyon, P. F., and Howlett, K. E., *Trans. Farad Soc.*, **45**, 733 (1949).
[6] Private communication from Dr. D. H. R. Barton.
[7] Fugassi, P., and Daniels, F., *J. Amer. Chem. Soc.*, **60**, 771 (1938).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, May 27

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Annual General Meeting and Open Scientific Meeting.

Wednesday, May 31

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. E. H. F. Baldwin: "The Biochemical Approach to Biological Organisation" (Inaugural Lecture).*

Thursday, June 1

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 2.30 p.m.—Annual General Meeting.

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Prof. C. K. Ingold, F.R.S.: "Nitration and Nitrating Agents".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT IN THE AGRICULTURAL DEPARTMENT, to be Editor of the *British Agricultural Bulletin* and to deputize for the Director of the Department—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, endorsed 'Agriculture' (June 3).

JUNIOR RESEARCH FELLOW in either one of the BIOLOGICAL SCIENCES or one of the PHYSICAL SCIENCES (including Mathematics)—The Provost, Queen's College, Oxford (June 3).

LECTURER (man) IN HORTICULTURE—The Secretary for Education, County Buildings, Shrewsbury (June 3).

LECTURER IN MATHEMATICS, a LECTURER IN ELECTRICAL ENGINEERING, and a LECTURER IN MECHANICAL ENGINEERING—The Registrar, Technical College, Sunderland (June 3).

LECTURER IN MATHEMATICS, a LECTURER IN METALLURGY, and a LECTURER IN PHYSICS, at the Constantine Technical College—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (June 3).

LECTURER IN MATHEMATICS, a LECTURER IN PHYSICS, and a LECTURER IN PHYSIOLOGY—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (June 3).

LECTURER IN THE SCHOOL OF PHARMACY, and a LECTURER IN CHEMISTRY, at the Plymouth and Devonport Technical College—The Director of Education, Education Offices, Cobourg Street, Plymouth (June 3).

ASSISTANT LECTURER IN AGRICULTURAL SCIENCE—The Principal, Institute of Agriculture, Usk, Mon. (June 5).

ENGINEER I (unestablished) at a Royal Ordinance Factory in Lancashire, for the design and development of special mechanical equipment for handling, processing and gauging new products—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.241/50A (June 5).

ANALYTICAL CHEMIST in the Directorate of Scientific Development—The Director of Establishments, Ministry of Finance, Stormont, Belfast (June 7).

RESEARCH ASSISTANT IN MATHEMATICS (with honours degree in Statistics or an honours degree in Mathematics) to carry out computation work in connexion with researches in progress in the University—The Registrar, The University, Sheffield (June 10).

SENIOR PROFESSIONAL OFFICER IN THE DEPARTMENT OF STATISTICS, Southern Rhodesia Government—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2, quoting Ref. 600/93A/1 (June 10).

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (June 12).

RADIO ENGINEERS as technical authors in the Ministry of Supply Air Technical Publications Branch in Surrey and Worcestershire—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting Ref. D.135/50A (June 12).

SENIOR LECTURER IN MATHEMATICS at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 15).

ASSISTANT CHEMIST IN THE DEPARTMENT OF GEOLOGICAL SURVEY, Southern Rhodesia Government—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (June 17).

ASSISTANT LECTURER or LECTURER IN BOTANY at Gordon Memorial College, Khartoum—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (June 17).

GRADUATE BIOCHEMIST to teach microbiology, chemistry and physics in relation to food, to day and evening students—The Secretary, Smithfield College of Food Technology, Eagle Court, St. John's Lane, London, E.C.1 (June 17).

JUNIOR ORGANIC CHEMISTS (with first- or second-class honours degree) to the British West Indies Sugar Research Scheme—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (June 17).

LECTURER IN PHYSICAL CHEMISTRY—The Secretary, The University, 38 North Bailey, Durham (June 17).

ELECTRICAL ENGINEERS (Electronics) in a Government of India Service establishment for training personnel in the maintenance and repair of equipment, one for high-powered wireless sets as used in the Services and one for modern radar equipment—The Secretary, General Department, Office of the High Commissioner of India, Aldwych, London, W.C.2, quoting No. 4/44B (June 19).

JUNIOR PLANT PHYSIOLOGIST (with good honours degree) to the British West Indies Cocoa Research Scheme—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (June 21).

READERSHIP IN AGRICULTURAL ECONOMICS at Wye College—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 21).

ASSISTANT LECTURER IN BOTANY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 24).

LECTURER or ASSISTANT LECTURER IN GEOGRAPHY (with an interest in meteorology) at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 24).

BRITISH COKE RESEARCH ASSOCIATION FELLOWSHIP in the Department of Coal Gas and Fuel Industries—The Registrar, The University, Leeds 2 (July 1).

INSTITUTION OF GAS ENGINEERS FELLOWSHIP for the prosecution of postgraduate research in gas chemistry—The Registrar, The University, Leeds 2 (July 1).

ROYAL DUTCH SHELL STUDENTSHIP IN GEOPHYSICS—Mr. B. C. Browne, Department of Geodesy and Geophysics, Downing Place, Cambridge (July 1).

CHAIR OF MECHANICAL ENGINEERING at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

ASSISTANT LECTURERS IN CHEMISTRY (with special qualifications in organic, physical or inorganic chemistry)—The Secretary, Royal Technical College, Glasgow.

BURSARY for postgraduate research on the formation, crystal structures, and properties of iron–carbon–nitrogen alloys, tenable at the Inorganic Chemistry Department, King's College, Newcastle-upon-Tyne—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

HONOURS GRADUATES IN PHYSICS AND CHEMISTRY, for research work in connexion with the pottery industry—The Director, British Ceramic Research Association, Queens Road, Penkhull, Stoke-on-Trent.

LECTURER IN AGRICULTURAL CHEMISTRY (with qualifications in Animal Nutrition)—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

LECTURER IN PHYSICS in the Department of Electrical Engineering and Physics, Rotherham Technical College—The Director of Education, Education Office, Domine Lane, Rotherham.

RESEARCH WORKER to take charge under Head of Nutrition Department of microbiological assay of vitamins and other factors—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

SENIOR ASSISTANT IN MECHANICAL ENGINEERING subjects (to teach heat engines and theory of machines to honours degree and H.N.C. standards), and a SENIOR ASSISTANT IN ELECTRICAL ENGINEERING subjects (to teach electrical technology and allied subjects to honours degree and H.N.C. standards), in the Cardiff Technical College—The Director of Education, City Hall, Cardiff.

SENIOR LECTURER (Senior Assistant), and a LECTURER, IN PHYSICS—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Report of the Pest Infestation Research Board, with the Report of the Director of Pest Infestation Research, for the Year 1948. Pp. iv+32. (London: H.M. Stationery Office, 1949.) 1s. net. [152

Philosophical Transactions of the Royal Society of London, Series A: Mathematical and Physical Sciences. No. 847. Vol. 242: The British Submarine Gravity Surveys of 1938 and 1946. By B. C. Brown and R. I. B. Cooper. Pp. 243–310. (London: Cambridge University Press, 1950.) 16s. [152

Department of Scientific and Industrial Research: Building Research Station. National Building Studies. Technical Paper, No. 3: Investigations on Granulated Blastfurnace Slags for the Manufacture of Portland Blastfurnace Cement. By Dr. T. W. Parker and R. W. Nurse. Pp. iv+20. (London: H.M. Stationery Office, 1949.) 9d. net. [152

Colonial Office. Appointments in His Majesty's Colonial Research Service. Pp. 15. (London: Colonial Office, 1950.) [162

Science Museum. Aeronautics—Heavier-than-Air Aircraft: a Brief Outline of the History and Development of Mechanical Flight with reference to the National Aeronautical Collection. By M. J. B. Davy. Part 1: Historical Survey. Pp. 76+18 plates. (London: H.M. Stationery Office, 1949.) 2s. 6d. net. [202

Proceedings of the Royal Society of Edinburgh, Section B (Biology). Vol. 63, Part 4: James Hutton, 1726–1797: Commemoration of the 150th Anniversary of his Death. Pp. v+351–402+4 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1950.) 12s. 6d. [202

Air Ministry: Meteorological Office. Professional Notes, No. 101: The Climates of Addu Atoll, Agalega Islands and Tristan da Cunha. By E. V. Newnham. (M.O. 524a.) Pp. 20+4 plates. (London: H.M. Stationery Office, 1949.) 6d. net. [202

Department of Scientific and Industrial Research. Report of the Building Research Board, with the Report of the Director of Building Research, for the Year 1948. Pp. iv+56+8 plates. (London: H.M. Stationery Office, 1949.) 1s. 6d. net. [202

Manchester Joint Research Council. Annual Report for 1949 and Report to the Council by the Executive Liaison Officer. Pp. 12. (Manchester: Manchester Joint Research Council, 1950.) [272

Air Ministry: Meteorological Office. Meteorological Reports, No. 4: Aviation Meteorology of the Route Marseilles–Castel Benito. (M.O. 496d.) Pp. ii+42. (London: H.M. Stationery Office, 1949.) 1s. 3d. net. [272

Crookes Vitamin Index. Pp. 54. (London: Crookes Laboratories, Ltd., 1949.) Free. [272

British Social Hygiene Council. Educational Paper No. 5: Human Physiology as a Practical Subject in School. By Richard Palmer. Pp. 14. (London: British Social Hygiene Council, 1950.) 1s. [282

General Register Office. The Registrar General's Estimates of the Population of England and Wales; Populations of each Administrative Area at 30th June, 1949. Pp. 16. (London: H.M. Stationery Office, 1950.) 4d. net. [282

Macaulay Institute for Soil Research. Annual Report, 1948–1949. Pp. 34. (Aberdeen: Macaulay Institute for Soil Research, 1949.) [282

Science Museum. British Fishing-Boats and Coastal Craft. Part 1: Historical Survey. Pp. 54+20 plates. (London: H.M. Stationery Office, 1950.) 2s. net. [282

Lundy Field Society. Third Annual Report, 1949. Pp. 51. (Exeter: L. A. Harvey, Secretary, University College, 1950.) [282

University of Birmingham: Joint Standing Committee for Research. Twentieth Annual Report, Session 1948–49. Pp. 81. (Birmingham: The University, 1950.) [282

Spot Welding of Mild Steel Slide Rule. (London: British Welding Research Association, 1950.) 1s. 6d. [282

British Association for Commercial and Industrial Education. Report on Junior Colleges in Scotland. Pp. 55. (London: British Association for Commercial and Industrial Education, 1950.) 1s. 6d. [282

Science Museum. Outline History of Transatlantic Steam Navigation, as illustrated by the Collections at the Science Museum. By H. P. Spratt. Pp. 59+9 plates. (London: H.M. Stationery Office, 1950.) 2s. net. [63

Department of Scientific and Industrial Research: Building Research Station. National Building Studies, Technical Paper, No. 4: Investigations on Building Fires. Part 1: The Estimation of the Maximum Temperature attained in Building Fires from Examination of the Debris, by Dr T. W. Parker and R. W. Nurse; Part 2: The Visible Changes in Concrete or Mortar exposed to High Temperatures, by G. E. Bessey. Pp. vi+18+4 plates. (London: H.M. Stationery Office, 1950.) 9d. net. [63

Manchester Museum: The University, Manchester. Report of the Museum Committee for the Year 1948–49. Pp. 24. (Manchester: The University, 1950.) [73

Carnegie Trust for the Universities of Scotland. Forty-eighth Annual Report (for the Year 1948–49) submitted by the Executive Committee to the Trustees on 27th February 1950. Pp. iv+68. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1950.) [73

British Library of Political and Economic Science. Annual Report, 1948–49. Pp. 22. (London: British Library of Political and Economic Science, 1949.) [73

World Federation for Mental Health. Annual Report with Proceedings of the Annual Meeting, 1948–49. Pp. 96. (London: World Federation for Mental Health, 1950.) [73

Ministry of Labour and National Service. Careers Guide: Opportunities in the Professions and in Business Management. Pp. 132. (London: H.M. Stationery Office, 1950.) 2s. 6d. net. [73

University of Leeds: The Brotherton Collection. The Fourteenth Annual Report of the Brotherton Collection Committee, Session 1948–49. Pp. 9. (Leeds: The University, 1950.) [73

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines for the Year 1948. Scottish Division. Report by A. H. Steele. Pp. ii+36. (London: H.M. Stationery Office, 1950.) 9d. net. [73

Equilibrium Data for Tin Alloys. Pp. 60. (Greenford: Tin Research Institute, 1949.) 2s. 6d. [73

Co-operation for Export Selling, by S. C. Turner; Distribution Costs, by Dr. Edward L. Lloyd. Pp. 31. 2s. 6d. Management Efficiency in Nationalized Undertakings. By I. J. Pitman. Pp. 19. 2s. The General Manager: Professional Assessment of Personality. By Sir Harold West. Pp. 14. 1s. 6d. Separating Judicial and Executive Functions. By J. S. Choate. Pp. 11. 1s. 6d. (London: British Institute of Management, 1950.) [73

Portable Fire Extinguishing Appliances. (Technical Booklet No. 6.) Pp. vi+33. (London: Fire Protection Association, 1950.) [93

Report of the 1948 Summer Symposium of the Acoustics Group—Noise and Sound Transmission. Pp. iv+200. (London: Physical Society, 1949.) 17s. 6d.; to Fellows and Members of the Acoustics Group, 10s. 6d. [93

Other Countries

Smithsonian Miscellaneous Collections. Vol. 113: Archæology of the Florida Gulf Coast. By Gordon R. Willey. (Publication 3988.) Pp. xxiii+599+60 plates. (Washington, D.C.: Government Printing Office, 1949.) [142

Federal Security Agency: Office of Education. Biennial Survey of Education in the United States, 1946–48. Chapter 6: Statistics of Libraries in Institutions of Higher Education, 1946–47. Prepared by Willard O. Mishoff and Emery M. Foster. Pp. v+49. (Washington, D.C.: Government Printing Office, 1949.) 20 cents. [142

Department of the Army: Beach Erosion Board. Technical Memorandum No. 11: Reflection of Solitary Waves. By Joseph M. Caldwell. Pp. v+19+16 plates. (Washington, D.C.: War Department, 1949.) [142

Iraq Natural History Museum. Publication No. 1: General Report (1946–1949.) Pp. 58. (Baghdad: Government Press, 1950.) [142

Report of the Committee on the Measurement of Geologic Time, 1948–1949. Presented for publication to the Division of Geology and Geography, National Research Council, September 1949. Pp. iii+139. (Washington, D.C.: National Research Council, 1949.) 1 dollar. [142

Canada: Department of Mines and Resources: Mines, Forests and Scientific Services Branch, Bureau of Mines. The Canadian Mineral Industry in 1947. (No. 827.) Pp. v+134. (Ottawa: Government Printer, 1949.) 25 cents. [142

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 29, Part 7: Studies in the Bromeliaceæ, XV. By Lyman B. Smith. Pp. v+277–316. (Washington, D.C.: Government Printing Office, 1949.) 20 cents. [142

British Guiana: Geological Survey. Bulletin No. 21: The Geology of the Aurora District, Cuyuni River, British Guiana. Pp. v+34. (Georgetown: Geological Department, 1949.) 1 dollar. [142

Pasteur Institute of Southern India. Annual Report of the Director, together with the Forty-second Annual Report of the Central Committee of the Pasteur Institute Association, 1948–49. Pp. 46. (Coonoor: Pasteur Institute, 1949.) [162

A Review of the Position reached in Technological Research on Jute. By C. R. Nodder. Pp. iii+76. (Calcutta: Indian Central Jute Committee, 1949.) [162

Conseil Permanent International pour l'Exploration de la Mer. Annales biologiques, Vol. 5, 1948. Rédigé par H. Blegvad avec l'aide de Aa. J. C. Jensen. Pp. 138. (Copenhague: Andr. Fred. Host et fils, 1949.) 18 kr. [162

A Design for the Layout of Indian Transport and Communication System. By Dr. Govind Balakrishna Deodikar. Pp. ix+97. (Bombay: Indian Society of Agricultural Economics, 1949.) 8 rupees. [162

Publicaciones de Medicine experimental. Vol. 2, ano 1947. Pp. 324. (Santiago: Universidad de Chile, 1947.) [162

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 24, No. 12: Contributions towards a Knowledge of the Insect Fauna of Lower California—Coleoptera: Cleridæ. By William F. Barr. Pp. 485–519. (San Francisco: California Academy of Sciences, 1950.) [202

Sciences modernes: Revue technique mensuelle des sciences, inventions et industries modernes. No. 1, Janvier. Pp. 32. (Jumet-Charleroi: Sciences modernes, 1950.) Annual subscription, 250 francs. [272

Australian Journal of Agricultural Research. Vol. 1, No. 1, January. Pp. 102. (Melbourne; Commonwealth Scientific and Industrial Research Organisation, 1950.) 30s. per annum. [272

Records of the Botanical Survey of India. Vol. 15, Part 2: Common Fresh and Brackish Water Algal Flora of India and Burma. By Dr. Kalipada Biswas. Pp. xi+169. (Delhi: Manager of Publications, 1949.) 15.8 rupees; 24s. [272

Journal of the American Chemical Society. Vol. 72, No. 1: Arthur Becket Lamb, Editor, Journal of the American Chemical Society, January 1, 1918 to December 31, 1949, President, American Chemical Society, 1933. Pp. 638. (Washington, D.C.: American Chemical Society, 1950.) 1 dollar. [272

Report on Federal Forest Administration in the Federation of Malaya for the Year 1948. By T. A. Strong. Pp. ii+52. (Kuala Lumpur: Government Printer, 1949.) 2 dollars; 4s. 8d. [272

Publications of the Dominion Observatory, Ottawa. Vol. 14: Bibliography of Seismology, No. 5, Items 7004–7131, January to June 1949. By W. G. Milne. Pp. 97–133. (Ottawa: King's Printer, 1950.) 25 cents. [282

Durban Museum and Art Gallery. Annual Report for Municipal Year 1948–1949. Pp. 8. (Durban: Durban Museum and Art Gallery, 1950.) [282

Fieldiana. Botany, Vol. 24, Part 6: Flora of Guatemala. By Paul C. Standley and Julian A. Steyermark. Pp. v+440. (Chicago: Chicago Natural History Museum, 1949.) 3.50 dollars. [282

Canada: Department of Mines and Resources: Mines, Forests and Scientific Services Branch. Geological Survey Bulletin, No. 14: Geology of part of the Selkirk Mountains in the vicinity of the Main Line of the Canadian Pacific Railway, British Columbia. By V. J. Okulitch. Pp. v+26 (4 plates). 25 cents. Geological Survey Memoir 252: Fort St. James Map-area, Cassiar and Coast Districts, British Columbia. By J. E. Armstrong. Pp. x+210+5 plates. 75 cents. (Ottawa: King's Printer, 1949.) [282

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 29, Part 8: Studies of South American Plants, 12. By A. C. Smith. Pp. viii+317–393. (Washington, D.C.: Government Printing Office, 1950.) 35 cents. [68

University of Illinois: Engineering Experiment Station. Bulletin Series No. 382: Fatigue Strength of various Details used for the Repair of Bridge Members. By Prof. Wilbur M. Wilson and Prof. William H. Munse. Pp. 58. 40 cents. Circular Series No. 57: A Survey of Electrical Insulation Practices. By Prof. Max A. Faucett, Constantine Houpis and George E. Leibinger. Pp. 96. 75 cents. Circular Series No. 58: Papers presented at the Eighth Conference on Coal Utilization held at the University of Illinois, September 27–28, 1948. Pp. 151. 75 cents. Reprint Series No. 45: Highway Bridge Floors. By Frank E. Richart, Nathan M. Newmark and Chester P. Siess. Pp. 929–1072. 30 cents. (Urbana: University of Illinois Engineering Experiment Station, 1949.) [63

Anuario del Observatorio Astronómico de Madrid para 1950. Pp. 382. (Madrid: Instituto Geográfico, 1949.) [73

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 238: The Non-parasitic Disorders of Apple Fruits in Australia. By W. M. Carne. Pp. 83+24 plates. (Melbourne: Government Printer, 1948.) [73

National Peking University Semi-Centennial Volume: Mathematical, Physical and Biological Series. Pp. 216+11 plates. (Peking: National Peking University Press, 1948.) [93

Catalogues

Electrical Thermometers. (List E.30.) Pp. 60. (London: Negretti and Zambra, Ltd., 1950.)

Microid Polishing Aluminas. (GT. 1386.) Pp. 4. (London: Griffin and Tatlock, Ltd., 1950.)

Noble Metal Catalysts. (Publication 1680.) Pp. 16. (London: Johnson, Matthey and Co., Ltd., 1950.)

Scientific Book Bulletin. No. 1. Pp. 12. (Cambridge: Bowes and Bowes, 1950.)

Stabilag Infra Red Heating Jackets. Pp. 8. Chatwood-York Autoclave. Pp. 4. (London: Electricals, Ltd., 1950.)

Doran Precision General Purpose D.C. Potentiometer. (List 106.) Pp. 2. Doran Thermo-Couple Potentiometer. (List 107.) Pp. 2. (Stroud: Doran Instrument Co., Ltd., 1950.)

Elliott Recording Dewpoint Hygrometer. (E/PN/24.) Pp. 2. (London: Elliott Brothers, Ltd., 1950.)